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Cyclopoid Copepods of the Genus *Lichomolgus* Associated with Octocorals of the Family Nephtheidae in Madagascar

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Cyclopoid Copepods of the Genus *Lichomolgus* Associated with Octocorals of the Family Nephtheidae in Madagascar

By Arthur G. Humes and Ju-Shey Ho [1]

Only one lichomolgid copepod, *Lichomolgus spinulifer* Humes and Frost, 1964, has been reported as an associate of nephtheid octocorals in Madagascar, where it lives on *Lemnalia* sp. This paper deals with six new species of *Lichomolgus* and with *L. spinulifer* washed from various species of Nephtheidae in the region of Nosy Bé in northwestern Madagascar.

All collections were made by A. G. Humes, those in 1960 during an expedition sponsored by the Academy of Natural Sciences of Philadelphia, and those in 1963–64 as part of the U.S. Program in Biology of the International Indian Ocean Expedition.

The study of the specimens has been aided by a grant (GB–5838) from the National Science Foundation of the United States.

All figures have been drawn with the aid of a camera lucida. The letter after the explanation of each figure refers to the scale at which it was drawn. The abbreviations used are: A_1=first antenna, A_2=second antenna, L=labrum, MXPD=maxilliped, and P_1=leg 1.

All descriptions are based on type material. The measurements of the length of the body have been made in all cases from specimens in

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lactic acid and do not include the setae on the caudal rami. The lengths of the segments of the first antenna have been measured along their posterior nonsetiferous margins.

We are indebted to Mme. A. Tixier-Durivault of the Muséum National d'Histoire Naturelle, Paris, for the identifications of the octocorals collected in 1960, and to Dr. J. Verseveldt, Zwolle, The Netherlands, for the determinations of those collected in 1963–64.

The new copepods described in this paper comprise the following:

1. *Lichomolgus varirostratus*, new species—from *Dendronephthya mucronata* (Pütter), *D. regia* Verseveldt, *D. stocki* Verseveldt, and *D. köllikeri* Kükenthal.
2. *Lichomolgus exilipes*, new species—from the same four species of *Dendronephthya*.
3. *Lichomolgus gentilis*, new species—from *Dendronephthya mucronata* (Pütter), *D. stocki* Verseveldt, *D. köllikeri* Kükenthal, *Stereonephthya acaulis* Verseveldt, and *S. papyracea* Kükenthal.
4. *Lichomolgus fissisetiger*, new species—from *Stereonephthya acaulis* Verseveldt, *S. papyracea* Kükenthal, and *Lemnalia elegans* (May).
5. *Lichomolgus cuneipes*, new species—from *Stereonephthya acaulis* Verseveldt.
6. *Lichomolgus aculeatus*, new species—from *Nephthea aberrans* Verseveldt, *N. sphaerophora* Kükenthal, *N. crassa* Kükenthal, *N. tixierae* Verseveldt, and *Litophyton arboreum* Forskål.

The following new hosts are recorded for *Lichomolgus spinulifer* Humes and Frost, 1964:

Lemnalia flava May, *L. elegans* (May), *L. amabilis* Tixier-Durivault, *L. africana* (May), and *Paralemnalia thyrsoides* (Ehrenberg).

Family Lichomolgidae Kossmann, 1877

Genus *Lichomolgus* Thorell, 1860

Lichomolgus varirostratus, new species

Figures 1–31

Type material.—133 ♀♀, 95 ♂♂, and 7 copepodids from a colony of *Dendronephthya mucronata* (Pütter), in 4 m, on the northeastern coast of Antany Mora, Isles Radama, Madagascar, 14°06′10″ S, 47°45′10″ E, collected Sept. 30, 1964. Holotype ♀, allotype, and 85 paratypes (50 ♀♀ and 35 ♂♂) deposited in the United States National Museum, the same number of paratypes in the Zoölogisch Museum,

Amsterdam, and the remaining paratypes in the collection of A. G. Humes.

OTHER SPECIMENS.—From *Dendronephthya mucronata:* 168 ♀♀ and 118 ♂♂ from 6 colonies, in 1 m, off Ampombilava, Nosy Bé, Madagascar, Sept. 26, 1964; 7 ♀♀ and 8 ♂♂ from 1 colony, in 1 m, Tany Kely, a small island south of Nosy Bé, June 23, 1963; 38 ♀♀, 36 ♂♂, and 4 copepodids from 1 colony, in 2 m, northern end of Nosy Sakatia, near Nosy Bé, Aug. 19, 1963; and 3 ♀♀ and 1 ♂ from 1 colony, in 20 m, Tany Kely, Dec. 20, 1963. From *Dendronephthya regia* Verseveldt: 5 ♀♀ and 1 ♂ from 1 colony, in 40 m, Banc de Cinq Mètres, west of Nosy Bé, at about 13°23′39″ S, 48°04′00″ E, Aug. 19, 1964. From *Dendronephthya stocki* Verseveldt: 3 ♀♀ from 1 colony, in 20 m, Tany Kely, Dec. 20, 1963, and 4 ♀♀ and 2 ♂♂ from 1 colony, in 40 m, Banc de Cinq Mètres, Aug. 19, 1964. From *Dendronephthya köllikeri* Kükenthal: 3 ♀♀ and 9 ♂♂ from 1 colony, in 8 m, Nosy Ovy, Isles Radama, 13°59′ S, 47°46.5′ E, Sept. 30, 1964.

FEMALE.—Body (fig. 1) with moderately broad prosome. Length 0.83 mm (0.77–0.90 mm) and greatest width (near middle of cephalosome) 0.47 mm (0.43–0.49 mm), based on 10 specimens. Ratio of length to width of prosome 1.24:1. Segment of first leg separated dorsally and laterally from head by a transverse furrow; lateral areas of this segment rounded posteriorly and not expanded. Lateral areas of segment bearing leg 2 expanded, those of segment of leg 3 expanded and slightly truncated, and those of segment of leg 4 small and rounded.

Segment of leg 5 (fig. 2) about twice as wide as long, 65μ x 120μ. Ventrally between this segment and genital segment a slight intersegmental sclerite. Genital segment (fig. 2) a little longer than wide, 138μ x 118μ, in dorsal view expanded in its midregion, anterior and posterior to which the segment is constricted (anterior constricted area set off ventrally from rest of segment by a weak transverse line). Areas of attachment of egg sacs situated dorsolaterally on posterior part of expanded area. Each area (fig. 3) with 2 naked spiniform setae, both about 11μ in length, and a prominent unguiform process. Three postgenital segments 36μ x 68μ, 26μ x 63μ, and 50μ x 62μ, from anterior to posterior.

Caudal ramus (fig. 4) about as long as wide, its greatest dimensions being 25μ x 28μ when measured dorsally and 29μ x 28μ when measured ventrally. Of the usual 6 setae, outer lateral seta 48μ long, pedicellate dorsal seta 26μ, outermost distal seta 73μ, innermost distal seta 122μ, and the 2 long median terminal setae 208μ (outer) and 290μ (inner) and both inserted between dorsal (unornamented) and ventral (with marginal rows of spinules) flaps. All these setae naked except

Surface of prosome and urosome with minute hairs as in female. Ratio of length of prosome to that of urosome 1.48:1.

Rostral area (fig. 24) angular, with a minute median posteroventral knob.

First antenna resembling that of female but with 2 aesthetes about 100μ long added on segment 2 and another such aesthete on segment 4 (at points indicated by arrows in fig. 7), so that formula is 4, 13+2 aesthetes, 6, 3+1 aesthete, 4+1 aesthete, 2+1 aesthete, and 7+1 aesthete. Second antenna (fig. 25) resembling that of female, but last segment relatively longer, 99μ along outer edge, 68μ along inner edge, and 21μ wide.

Labrum, mandible, paragnath, first maxilla, and second maxilla like those in female. Maxilliped (fig. 26) slender and 4-segmented (assuming that proximal part of claw represents fourth segment). First segment unornamented. Second segment bearing on medial surface 2 naked setae and 3 rows of spinules, a single row extending the length of segment, other 2 rows close together and restricted to region distal to setae. Third segment very small and unarmed. Claw slender, 185μ long (measured along its axis), with narrow terminal lamella, slight fringe along its distal concave surface, and 2 very unequal setae near its base, one on postero-inner surface 86μ long and finely barbed at its tip, other on anterior surface only 5μ and naked. Claw showing a suggestion of division about midway.

Area between maxillipeds and first pair of legs resembling that of female.

Legs 1–4 segmented as in female and with same spine and setal formula, except for endopod of leg 1 (fig. 27), which has arrangement of 0–1; 0–1; I,I,4. This endopod geniculate, with second and third segments set at an angle to one another. First two segments without outer distal spinous processes. Third segment elongated, nearly as long as first two combined; with 2 terminal spines having strong lateral spinules; a prominent minutely spinose process near insertion of inner of these spines. Last segment of endopod of leg 2 (fig. 28) with 2 of terminal spinous processes larger than in female and bearing numerous minute spines. Legs 3 and 4 like those in female.

Leg 5 (fig. 29) with elongated slender straight free segment, 33μ x 9μ, with nearly parallel sides in dorsal view, bearing a few surficial scales and 2 terminal elements, an outer naked seta 30μ long and an inner spiniform seta 20μ long with coarse short lateral spines. No spinules on body near insertion of free segment.

Leg 6 (fig. 30) a posterolateral flap on ventral surface of genital segment bearing 2 naked setae 22μ and 27μ long.

Spermatophore (fig. 31), attached to female, elongated, 172μ x 78μ without neck. Spermatophores readily extruded from male when placed in lactic acid, as shown in figure 30.

Color in life resembling that of female.

ETYMOLOGY.—The specific name *varirostratus*, from Latin *varius*=different and *rostratus*=furnished with a beak, alludes to the different shape of the rostrum in the two sexes of this species.

COMPARISON WITH RELATED SPECIES.—Two features of *L. varirostratus* serve to distinguish it from all other known species in the genus, namely, the presence of a spine instead of a seta on the first segment of the endopod of leg 4 and the two unusually long terminal claws on the second antenna. In only one other species, *L. anomalus* A. Scott, 1909, does the endopod of leg 4 appear to have the formula 0–I, II (based on Scott's fig. 15, pl. LXVII); the usual formula in *Lichomolgus* is 0–1, II. Scott's species differs from the new species, however, in having only one claw on the second antenna. The general structure of the endopod in leg 1 of the male of *L. varirostratus* resembles rather closely that of *L. anomalus*. Scott noted that this geniculate form "is quite distinct from what is usually found in males of this genus."

Two unusually long terminal claws occur on the second antenna in four species—*L. canui* Sars, 1917; *L. ieversi* Thompson and A. Scott, 1903; *L. marginatus* Thorell, 1860; and *L. tenuicornis* Brady, 1910—but in all of these species the formula for the endopod of leg 4 is 0–1, II, thus readily separating them from the new species from Madagascar.

Lichomolgus exilipes, new species

FIGURES 32–55

TYPE MATERIAL.—31 ♀♀ and 18 ♂♂ from a colony of *Dendronephthya mucronata* (Pütter), in 4 m, on the northeastern coast of Antany Mora, Isles Radama, Madagascar, 14°06′10″S, 47°45′10″E, collected Sept. 30, 1964. Holotype ♀, allotype, and 35 paratypes (25 ♀♀ and 10 ♂♂) deposited in the United States National Museum, and the remaining paratypes in the collection of A. G. Humes.

OTHER SPECIMENS.—From *Dendronephthya mucronata:* 15 ♀♀ and 8 ♂♂ from 6 colonies, in 1 m, off Ampombilava, Nosy Bé, Madagascar, Sept. 26, 1964, and 6 ♂♂ from 1 colony, in 1 m, Tany Kely, a small island south of Nosy Bé, June 23, 1963. From *Dendronephthya regia* Verseveldt: 2 ♀♀ from 1 colony, in 40 m, Banc de Cinq Mètres, west of Nosy Bé, at about 13°23′30″S, 48°04′00″E, Aug. 19, 1964. From *Dendronephthya stocki* Verseveldt: 1 ♀ and 6 ♂♂ from 1 colony,

in 40 m, Banc de Cinq Mètres, Aug. 19, 1964. From *Dendronephthya köllikeri* Kükenthal: 7 ♀♀ and 12 ♂♂ from 1 colony, in 8 m, Nosy Ovy, Isles Radama, 13°59′S, 47°46.5′E, Sept. 30, 1964.

FEMALE.—Body (fig. 32) a little less broadened than in *L. varirostratus*. Length 0.99 mm (0.91–1.09 mm) and greatest width 0.50 mm (0.46–0.52 mm), based on 10 specimens. Ratio of length to width of prosome 1.3:1. Segment of first leg separated dorsally and laterally from head by a furrow. Lateral areas of segments of legs 1–4 shaped as in figure.

Segment of leg 5 measuring 73μ x 151μ. Between this segment and genital segment a slight ventral intersegmental sclerite. Genital segment (fig. 33) slightly longer than wide, 172μ x 156μ, in dorsal view constricted anteriorly and posteriorly but expanded in midregion. A pair of crescentic sclerotized ridges on anterior dorsal surface. Areas of attachment of egg sacs located dorsolaterally at level of expanded part of segment. Each area (fig. 34) bearing 2 naked setae 11μ and 20μ in length, with a small digitiform process between them. Three postgenital segments 34μ x 81μ, 23μ x 68μ, and 34μ x 70μ, from anterior to posterior.

Caudal ramus (fig. 35) only slightly longer than wide, its greatest dimensions being 30μ x 25μ when measured dorsally and 33μ x 25μ when measured ventrally. Outer lateral seta 109μ and naked, pedicellate dorsal seta 22μ and naked, outermost distal seta 180μ and naked, innermost distal seta 283μ with inner lateral spinules, and the 2 long median terminal setae 418μ (outer) and 550μ (inner), both inserted between dorsal (unornamented) and ventral (with marginal row of spinules) flaps, and bearing lateral spinules in their midregions. A delicate setule on proximal outer edge of ramus, and a few surficial hairs dorsally.

Dorsal surface of prosome and urosome with minute hairs. Ratio of length of prosome to that of urosome 2.24:1.

Egg sacs in most ovigerous females observed broken, as in figure 32. One intact egg sac measuring 430μ x 176μ, elongated, reaching well beyond ends of caudal rami, and containing many small eggs, each about 40μ in diameter.

Rostral area (fig. 36) linguiform, rounded posteroventrally.

First antenna (fig. 37) resembling in general form that of *L. varirostratus*, with same segmentation and formula for armature, but longer, 480μ. Lengths of segments: 36μ (77μ along anterior margin), 133μ, 32μ, 70μ, 75μ, 56μ, and 36μ respectively. All setae naked.

Second antenna (fig. 38) also resembling that of *L. varirostratus*, with similar segmentation and armature. Last segment 135μ along its outer edge, 86μ along its inner edge, and 31μ wide. Three setae on

third segment 42μ, 21μ, and 42μ from proximal to distal, with distalmost spiniform and minutely barbed along one edge. Both claws about 135μ in length.

Labrum (fig. 39) with 2 posteroventral lobes less broadly rounded than in *L. varirostratus*.

Mandible (fig. 40) resembling that of *L. varirostratus*, but with distinct constriction separating basal region into two parts, convex margin of distal part bearing spinules and projected distally as a short blunt process. Paragnath a small lobe bearing hairs. First maxilla (fig. 41) bearing a small subterminal element in addition to 3 terminal ones. Second maxilla (fig. 42) and maxilliped (fig. 43) segmented and armed as in *L. varirostratus*, but slight differences in ornamentation of elements as shown in figures.

Area between maxillipeds and first pair of legs (fig. 44) not protuberant; a sclerotized line between bases of maxillipeds.

Legs 1–4 (figs. 45–48) segmented as in *L. varirostratus*, with same spine and setal formula. Inner seta on coxa of leg 4 short (12μ) and naked. Inner margin of basis of leg 4 without hairs. In leg 1 spinules along proximal margins of outer spines of exopod longer and coarser than those on distal margins. Endopod of leg 4 only slightly shorter than exopod. First segment 56μ x 35μ (including terminal spinous processes), bearing an inner distal minutely barbed spine 43μ long. Second segment 111μ x 30μ (greatest dimensions including processes), bearing 2 terminal barbed spines 39μ (outer) and 77μ (inner); a few minute spinules along inner margin of segment.

Leg 5 (fig. 49) with free segment much elongated, slender, and slightly arcuate, 172μ x 23μ (width 35μ at level of proximal inner expansion). Outer convex surface bearing pointed scales. Two terminal naked setae 122μ and 190μ in length. Naked seta on body near free segment 55μ, with a few minute spinules not far from its insertion.

Leg 6 probably represented by the 2 setae near areas of attachment of each egg sac (see fig. 34).

Color in life in transmitted light as in *L. varirostratus*.

MALE.—Body (fig. 50) resembling that of female in general form. Length 0.78 mm (0.73–0.81 mm) and greatest width 0.34 mm (0.30–0.36 mm), based on 10 specimens. Ratio of length to width of prosome 1.4:1.

Segment of leg 5 measuring 36μ x 101μ. Genital segment (fig. 51) about as long as wide, 221μ x 216μ. No ventral intersegmental sclerite between these segments. Four postgenital segments 22μ x 56μ, 17μ x 55μ, 11μ x 51μ, and 24μ x 56μ respectively.

Caudal ramus (fig. 51) somewhat shorter than in female, 22μ x 24μ dorsally, 23μ x 24μ ventrally. Innermost terminal seta with row of

spinules on both sides. Outermost terminal seta with inner spinules proximally.

Surfaces of prosome and urosome with minute hairs as in female. Ratio of length of prosome to that of urosome 1.43:1.

Rostral area as in female.

First antenna resembling that of female, but with 2 long aesthetes added on second segment and another aesthete on fourth segment, so that formula is same as for male of *L. varirostratus*.

Second antenna, labrum, mandible, paragnath, first maxilla, and second maxilla similar to those in female. Maxilliped (fig. 52) less slender than in *L. varirostratus*, but segmented and armed similarly. Claw slender and 170μ along its axis; proximal region of claw slightly swollen and faintly striated.

Area between maxilliped and first pair of legs as in female.

Legs 1–4 segmented as in *L. varirostratus*, with spine and setal formula as in male of that species. Endopod of leg 1 (fig. 53) slightly geniculate. Third segment elongated, with outer terminal spine straight, having lateral spinules and hyaline tip, inner terminal spine bent, with strong spinules along its inner distal edge; spinous process between these 2 spines enlarged and finely spinose. No obvious sexual dimorphism in legs 2–4.

Leg 5 (fig. 54) with a very elongated slender straight free segment, 55μ x 11μ, bearing on its outer surface a few scales and terminally an outer naked seta 56μ long and an inner spine 29μ long with short lateral spinules. No spinules on body near insertion of free segment.

Leg 6 similar to that in *L. varirostratus*, with 2 naked setae 41μ and 78μ in length.

Spermatophore (fig. 55), attached to female, elongated, 174μ x 91μ, not including neck.

Color in life as in *L. varirostratus*.

ETYMOLOGY.—The specific name *exilipes*, from Latin *exilis*=slender and *pes*=foot, refers to the elongated slender form of leg 5 in both sexes of this species.

COMPARISON WITH RELATED SPECIES.—Like *L. varirostratus*, this species may be distinguished from all other known species in the genus on the basis of a combination of two characters: the spine (instead of a seta) on the first segment of the endopod of leg 4 and the two unusually long terminal claws on the second antenna.

Lichomolgus exilipes may readily be separated from *L. varirostratus* by the form of the rostrum, the presence of lateral spinules on the two long setae on the caudal rami, the form of the fifth legs and the genital segment in the female, and the structure of the two spines on the last segment of the endopod of leg 1 in the male.

***Lichomolgus gentilis*, new species**

FIGURES 56–69

TYPE MATERIAL.—20 ♀♀ and 28 ♂♂ from a colony of *Dendronephthya mucronata* (Pütter), in 4 m, on the northeastern coast of Antany Mora, Isles Radama, Madagascar, 14°06′10″S, 47°45′10″E, collected Sept. 30, 1964. Holotype ♀, allotype, and 36 paratypes (14 ♀♀ and 22 ♂♂) deposited in the United States National Museum and the remaining paratypes in the collection of A. G. Humes.

OTHER SPECIMENS.—From *Dendronephthya mucronata:* 4 ♀♀ from 6 colonies, in 1 m, off Ampombilava, Nosy Bé, Madagascar, Sept. 26, 1964; 10 ♀♀ and 19 ♂♂ from 1 colony, in 1 m, Tany Kely, a small island south of Nosy Bé, June 23, 1963; 2 ♀♀ from 1 colony, in 2 m, northern end of Nosy Sakatia, near Nosy Bé, Aug. 19, 1963; and 2 ♀♀ and 1 ♂ from 1 colony, in 20 m, Tany Kely, Dec. 20, 1963. From *Dendronephthya köllikeri* Kükenthal: 15 ♀♀ and 19 ♂♂ from 1 colony, in 8 m, Nosy Ovy, Isles Radama, 13°59′S, 47°46.5′E, Sept. 30, 1964. From *Dendronephthya stocki* Verseveldt: 1 ♂ from 1 colony, in 20 m, Tany Kely, Dec. 20, 1963. From *Stereonephthya acaulis* Verseveldt: 1 ♀, 2 ♂♂, and 45 copepodids from 1 colony, in 20 m, Tany Kely, Dec. 20, 1963; 5 ♀♀, 22 ♂♂, and 1 copepodid from 1 colony, in 10 m, Tany Kely, Aug. 21, 1964; 11 ♀♀ and 8 ♂♂ from 1 colony, in 1 m, off Ampombilava, Nosy Bé, Sept. 26, 1964; and 15 ♀♀, 9 ♂♂, and 1 copepodid from 1 colony, in 2 m, Andraikarekabe, Nosy Komba, near Nosy Bé, Oct. 9, 1964. From *Stereonephthya papyracea* Kükenthal: 39 ♀♀ and 52 ♂♂ from 1 colony, in 6 m, Tany Kely, Aug. 26, 1963.

FEMALE.—Body (fig. 56) with moderately broad prosome. Length 0.91 mm (0.82–1.03 mm) and greatest width 0.47 mm (0.45–0.49 mm), based on 10 specimens. Ratio of length to width of prosome 1.28:1.

Segment of leg 5 measuring 52μ x 159μ. Between this segment and genital segment no ventral intersegmental sclerite visible. Genital segment (fig. 57) nearly as long as wide, 148μ x 159μ, in dorsal view expanded in its anterior three-fourths but constricted posteriorly. Areas of attachment of egg sacs located dorsolaterally on posterior part of expanded region. Each area (fig. 58) with a slender naked seta 13μ long, a spiniform unilaterally barbed seta 18μ long, and an adjacent slender setiform process. Three postgenital segments 26μ x 86μ, 20μ x 82μ, and 25μ x 77μ from anterior to posterior.

Caudal ramus (fig. 57) a little shorter than wide, its greatest dimensions being 25μ x 32μ when measured dorsally and 27μ x 32μ when measured ventrally. Outer lateral seta 143μ long and naked, pedicellate dorsal seta 39μ and naked, outermost distal seta 235μ and naked, innermost distal seta 352μ with row of spinules along inner edge, and the 2 long median terminal setae 517μ (outer) and 583μ (inner), both inserted between dorsal (unornamented) and

ventral (with marginal row of spinules) flaps, and both with strong coarse lateral spinules in midregion (these spinules much stronger than in *L. exilipes*).

Ratio of length of prosome to that of urosome 2.5:1.

Most ovigerous females observed carrying only clusters of eggs as in figure 56. One of few intact egg sacs measuring 462μ x 198μ, elongated oval, reaching far beyond caudal rami, with each egg about 44μ in diameter.

Rostral area and first antenna (453μ long) resembling those of *L. exilipes*. Second antenna (fig. 59) formed in general like that of *L. exilipes*, but 3 elements on third segment 35μ, 24μ, and 25μ from proximal to distal. Last segment 130μ along its outer edge, 83μ along its inner edge, and 31μ wide. Two terminal claws different in form and length, one being slender and 143μ along its axis, other stout and 127μ. (Apparently some variation in lengths of claws, with one female 153μ and 117μ on one side and 146μ and 130μ on other. In one female from *Stereonephthya acaulis* 120μ and 99μ, and in another 125μ and 107μ. In all cases, however, longer claw slender, shorter one stout.)

Labrum as in *L. exilipes*. Mandible (fig. 60) without blunt process on convex margin of basal region as in *L. exilipes*. Paragnath, first maxilla, and second maxilla similar to those in *L. exilipes*. Maxilliped (fig. 61) differing only slightly from that species.

Area between maxillipeds and first pair of legs not protuberant, with a sclerotized line connecting bases of maxillipeds.

Legs 1–4 segmented as in 2 previous species, with same spine and setal formula. Inner seta on coxa of leg 4 short (10μ) and naked. Inner margin of basis of leg 4 without hairs. In leg 1 (fig. 62) and leg 2 spinules along proximal margins of outer spines of exopod longer and stouter than those on distal margins. Endopod of leg 4 (fig. 63) shorter than exopod. First segment 55μ x 34μ (including terminal spinous processes), bearing an inner distal finely barbed spine 35μ long. Second segment 99μ x 34μ (greatest dimensions including processes), bearing 2 terminal spines, outer 44μ and finely barbed, inner 79μ with lateral spinules; a row of long hairs along proximal two-thirds of inner margin of segment.

Leg 5 (fig. 64) with elongated free segment, 143μ x 20μ (width taken at level of proximal inner expansion). Outer convex surface with pointed scales. Two terminal naked setae 99μ and 148μ in length. Seta on body near insertion of free segment 40μ long and slightly plumose; a few small spinules near this seta.

Leg 6 probably represented by the 2 setae near areas of attachment of each egg sac (see fig. 58).

Color in life in transmitted light as in 2 previous species.

MALE.—Body (fig. 65) resembling that of female in general aspect. Length 0.72 mm (0.69–0.77 mm) and greatest width 0.34 mm (0.32–0.36 mm), based on 10 specimens. Ratio of length to width of prosome 1.36:1.

Segment of leg 5 measuring 39μ x 104μ. Genital segment (fig. 66) as long as wide, 200μ x 203μ. No ventral intersegmental sclerite between these segments. Four postgenital segments 15μ x 61μ, 17μ x 57μ, 12μ x 56μ, and 22μ x 58μ respectively.

Caudal ramus as in female, but proportions slightly different, 20μ x 24μ dorsally, 27μ x 24μ ventrally. As in *L. exilipes*, outermost terminal seta with inner spinules proximally and innermost terminal seta with row of spinules on both sides.

Ratio of length of prosome to that of urosome 1.7:1.

Rostral area as in female. First antenna similar to that of female, but with 3 aesthetes added (length of proximalmost=130μ) so that formula is same as for males of 2 previous species. Second antenna, labrum, mandible, paragnath, first maxilla, and second maxilla like those of female. Maxilliped (fig. 67) with general form similar to *L. exilipes*, but ornamentation of major setae slightly different. Claw slender and 172μ along its axis.

Area between maxillipeds and first pair of legs as in female.

Legs 1–4 segmented as in 2 previous species, with spine and setal formula as in males of those species. Endopod of leg 1 (fig. 68) only slightly geniculate. Third segment moderately elongated, with outer terminal spine straight, having lateral spinules and small hyaline tip, inner terminal spine slightly bent (not as strongly so as in *L. exilipes*) with moderately strong spinules along its inner distal edge; spinous process between these 2 spines as in *L. exilipes*. No obvious sexual dimorphism in legs 2–4, except that endopod of leg 4 (fig. 69) has slightly different proportions: first segment 33μ x 25μ, with spine 25μ, second segment 70μ x 22μ (more elongated than in female, ratio 3.2:1 instead of 2.9:1 as in that sex), with 2 terminal spines 31μ and 61μ.

Leg 5 (fig. 66) with elongated free segment, 57μ x 11μ, without pronounced proximal inner expansion, bearing on its outer surface a few scales and terminally an outer naked seta 71μ and an inner barbed spine 19μ. No spinules on body near insertion of free segment.

Leg 6 similar to those in 2 previous species, with 2 naked setae 50μ and 82μ in length.

Spermatophore, attached to female, as in *L. exilipes*.

Color in life as in 2 previous species.

ETYMOLOGY.—The specific name *gentilis*, from Latin=belonging to the same gens or clan, alludes to the close relationship of this species with *L. exilipes*.

COMPARISON WITH RELATED SPECIES.—Like *L. varirostratus* and *L. exilipes* this species may be distinguished from all other members of the genus by the combination of two characters: the spine (instead of a seta) on the first segment of the endopod of leg 4 and the two unusually long terminal claws on the second antenna.

Lichomolgus gentilis may be readily separated from *L. varirostratus* by the form of the rostrum, the presence of lateral spinules on the two long setae on the caudal rami, the form of the genital segment in the female, and the structure of the two spines on the last segment of the endopod of leg 1 in the male.

From *L. exilipes* the new species may be separated by the coarser lateral spinules on the two long setae on the caudal rami, the more unequal nature of the two claws on the second antenna, the lack of a blunt process on the inner margin of the mandible, and the form of the fifth legs and the genital segment in the female.

Lichomolgus fissisetiger, new species

FIGURES 70–83

TYPE MATERIAL.—24 ♀♀ and 20 ♂♂ from a colony of *Stereonephthya acaulis* Verseveldt, in 2 m, Ambafaho, Nosy Bé, Madagascar, collected Sept. 25, 1964. Holotype ♀, allotype, and 34 paratypes (18 ♀♀ and 16 ♂♂) deposited in the United States National Museum, and the remaining paratypes in the collection of A. G. Humes.

OTHER SPECIMENS.—From *Stereonephthya acaulis:* 45 ♀♀ and 89 ♂♂ from 1 colony, in 10 m, Tany Kely, a small island south of Nosy Bé, Aug. 21, 1964; 22 ♀♀, 9 ♂♂, and 2 copepodids from 1 colony, in 1 m, off Ampombilava, Nosy Bé, Sept. 26, 1964; and 9 ♀♀ and 16 ♂♂ from 1 colony, in 2 m, Andraikarekabe, Nosy Komba, near Nosy Bé, Oct. 9, 1964. From *Stereonephthya papyracea* Kükenthal: 53 ♀♀, 80 ♂♂, and 92 copepodids from 1 colony, in 6 m, Tany Kely, Aug. 26, 1963. From *Lemnalia elegans* (May): 3 ♀♀ from 1 colony, in 1 m, Pte. Lokobe, Nosy Bé, Oct. 16, 1960.

FEMALE.—Body (fig. 70) similar to that of *L. exilipes* and *L. gentilis*. Length 0.99 mm (0.92–1.03 mm) and greatest width 0.49 mm (0.46–0.51 mm), based on 10 specimens. Ratio of length to width of prosome 1.5:1.

Segment of leg 5 measuring 65μ x 143μ. Between this segment and genital segment a small ventral intersegmental sclerite. Genital segment (fig. 71) slightly shorter than wide, 127μ x 143μ, in dorsal view with its lateral borders rounded. Areas of attachment of egg sacs located almost laterally (only slightly dorsally) in posterior half of segment. Each area (fig. 72) with 2 small naked setae about 11μ long and an adjacent small unguiform process. Three postgenital segments 26μ x 82μ, 21μ x 73μ, and 26μ x 70μ from anterior to posterior.

Caudal ramus (fig. 73) shorter than wide, its greatest dimensions being 20μ x 28μ when measured dorsally, 21μ x 28μ when measured ventrally. Outer lateral seta 83μ long and naked, pedicellate dorsal seta 25μ and naked, outermost distal seta 117μ with proximal inner spinules, innermost distal seta 208μ with spinules along both sides, and the 2 long median terminal setae 440μ (outer) and 590μ (inner), both inserted between dorsal (unornamented) and ventral (with marginal row of spinules) flaps, and both with lateral spinules in midregion (these spinules not as strong as in *L. gentilis*, and more like those of *L. exilipes*).

Ratio of length of prosome to that of urosome 2.9:1.

Egg sac (fig. 70) 550μ x 209μ, elongated, reaching far beyond ends of caudal rami, containing many eggs, each about 45μ in diameter.

Rostral area and first antenna (428μ long) similar to those of *L. exilipes* and *L. gentilis*. Second antenna (fig. 74) resembling that of *L. gentilis*, but differing in details. Three naked elements on third segment 35μ, 21μ, and 20μ in length from proximal to distal. Last segment 94μ along outer margin, 60μ along inner margin, and 25μ wide. Two terminal claws unequal, not as long as in *L. gentilis*, one 92μ along its axis and slender, the other 77μ and stouter.

Labrum as in *L. exilipes* and *L. gentilis*. Mandible (fig. 75) similar to that in *L. gentilis*, but showing an even more pronounced constriction of basal region. Paragnath and first maxilla as in *L. exilipes* and *L. gentilis*. Second maxilla (fig. 76) resembling *L. exilipes* and *L. gentilis*, but spinulation of lash and distal seta slightly different. Maxilliped as in *L. exilipes* and *L. gentilis*.

Area between maxillipeds and first pair of legs not protuberant, with a sclerotized line between bases of maxillipeds.

Legs 1–4 segmented as in 3 previous species, with same spine and setal formula. Leg 1 similar to that of *L. exilipes* and *L. gentilis*. Legs 2 and 3 like those of *L. exilipes*. Leg 4 (fig. 77) resembling that of *L. gentilis*. Endopod shorter than exopod. First segment 42μ x 32μ (including terminal spinous processes), with inner distal minutely barbed spine 31μ long. Second segment 90μ x 29μ (greatest dimensions including processes), outer terminal spine 34μ with finely barbed fringe, inner 72μ with more coarsely spinulose fringe. Proximal inner margin of this segment with row of very short spinules.

Leg 5 (fig. 78) with elongated free segment having prominent inner basal expansion. Greatest length 148μ, width 42μ at expansion, 23μ immediately distal to expansion, and 16μ near tip. Outer surface with narrow scalelike spines. Two terminal naked setae 72μ and 110μ (the latter with a narrow membrane in its midregion). Seta on body near insertion of free segment about 50μ long and slightly plumose; a few small spinules near this seta.

Leg 6 probably represented by the 2 setae near areas of attachment of each egg sac (see fig. 72).

Color in life in transmitted light somewhat opaque, eye red, ovary dark gray, egg sacs gray.

MALE.—Body (fig. 79) resembling that of female in general form. Length 0.78 mm (0.74–0.81 mm) and greatest width 0.29 mm (0.27–0.30 mm), based on 10 specimens. Ratio of length to width of prosome 1.48:1.

Segment of leg 5 measuring 36μ x 91μ. Genital segment (fig. 80) as long as wide, 185μ x 185μ. No ventral intersegmental sclerite between these segments. Four postgenital segments 17μ x 50μ, 14μ x 52μ, 12μ x 50μ, and 19μ x 52μ respectively.

Caudal ramus resembling that of female but smaller, 14μ x 22μ dorsally, 18μ x 22μ ventrally.

Ratio of length of prosome to that of urosome 1.62:1.

Rostral area as in female. First antenna similar to that of female, but with 3 aesthetes added as in 3 previous species, so that formula is same as for those males. Aesthetes much longer than in preceding species, proximalmost one 240μ in length. Second antenna, labrum, mandible, paragnath, first maxilla, and second maxilla like those in female. Maxilliped resembling in general form that of *L. gentilis*, but one of setae on inner surface of second segment terminating in several pointed spiniform elements (fig. 81). Claw 133μ in length (measured along its axis).

Area between maxillipeds and first pair of legs as in female.

Legs 1–4 segmented as in 3 previous species, with spine and setal formula as in those males. Endopod of leg 1 (fig. 82) only slightly geniculate. Third segment resembling that of *L. gentilis*. Legs 2–4 as in female.

Leg 5 (see fig. 80) resembling that of *L. exilipes*, with free segment 52μ x 9μ, terminally with inner spine 18μ and barbed, outer seta 68μ and naked.

Leg 6 (fig. 83) similar to that in 3 preceding species, with 2 naked setae 44μ and 66μ in length.

Spermatophore not observed.

Color in life in transmitted light more translucid than in female, eye red, genital segment hyaline.

ETYMOLOGY.—The specific name *fissisetiger*, from Latin *fissus*=split and *setiger*=bearing a seta, refers to the nature of the seta on the second segment of the maxilliped in the male of this species.

COMPARISON WITH RELATED SPECIES.—Like the three preceding species *L. fissisetiger* may be distinguished from all other members of the genus by the combination of two characters: the spine (instead

of a seta) on the first segment of the endopod of leg 4 and the two unusually long terminal claws on the second antenna.

Lichomolgus fissisetiger may be separated from *L. varirostratus* by the form of the rostrum, the presence of lateral spinules on the two long setae of the caudal rami, the form of the genital segment and leg 5 in the female, the long aesthetes on the first antenna of the male, and the structure of the two spines on the last segment of the endopod of leg 1 in the male.

It may be distinguished from *L. exilipes* by the form of the genital segment and leg 5 in the female, the more unequal nature of the two claws on the second antenna, the lack of a blunt process on the inner margin of the mandible, the peculiar split seta on the second segment of the maxilliped in the male, and the long aesthetes on the first antenna of the male.

From *L. gentilis* the new species may be distinguished by the form of the genital segment and leg 5 in the female, the pronounced constriction of the basal region of the mandible, the split seta on the second segment of the maxilliped in the male, and the long aesthetes on the first antenna of the male.

Lichomolgus cuneipes, new species

FIGURES 84–96

TYPE MATERIAL.—39 ♀♀ and 18 ♂♂ from a colony of *Stereonephthya acaulis* Verseveldt, in 1 m, off Ampombilava, Nosy Bé, Madagascar, collected Sept. 26, 1964. Holotype ♀, allotype, and 46 paratypes (32 ♀♀ and 14 ♂♂) deposited in the United States National Museum, and the remaining paratypes in the collection of A. G. Humes.

OTHER SPECIMENS (all from *Stereonephthya acaulis*).—6 ♀♀ and 3 ♂♂ from 1 colony, in 2 m, Ambafaho, Nosy Bé, Sept. 25, 1964; 9 ♀♀ and 10 ♂♂ from 1 colony, in 10 m, Tany Kely, a small island south of Nosy Bé, Aug. 21, 1964; and 11 ♀♀ and 9 ♂♂ from 1 colony, in 2 m, Andraikarekabe, Nosy Komba, near Nosy Bé, Oct. 9, 1964.

FEMALE.—Body (fig. 84) resembling that of *L. fissisetiger*. Length 0.94 mm (0.89–0.98 mm) and greatest width 0.48 mm (0.45–0.49 mm), based on 10 specimens. Ratio of length to width of prosome 1.56:1.

Segment of leg 5 measuring 65μ x 138μ. Between this segment and genital segment a small ventral intersegmental sclerite. Genital segment (fig. 85) about as long as wide, 125μ x 120μ, in dorsal view with its lateral borders somewhat irregular. Areas of attachment of egg sacs located dorsolaterally in middle of segment. Each area (fig. 86) with 2 small naked setae about 8μ long with a pointed sclerotized process between them. Three postgenital segments 26μ x 75μ, 21μ x 71μ, and 26μ x 71μ from anterior to posterior.

Caudal ramus (fig. 87) shorter than wide, its greatest dimensions being 22μ x 30μ when measured dorsally, 24μ x 30μ when measured ventrally. Outer lateral seta 75μ long, pedicellate dorsal seta 28μ, outermost distal seta 112μ, innermost distal seta 203μ, and the 2 long median terminal setae 380μ (outer) and 495μ (inner), both inserted between dorsal and ventral flaps as in previous species. All setae naked.

Ratio of length of prosome to that of urosome 2.78:1.

Egg sac (fig. 84) 462μ x 187μ, elongated, reaching far beyond ends of caudal rami, containing many eggs, each about 45μ in diameter.

Rostral area (fig. 88) broadly rounded posteroventrally.

First antenna (410μ long) similar to that of *L. exilipes*, the segments 31μ (61μ along anterior edge), 133μ, 28μ, 57μ, 56μ, 42μ, and 32μ in length respectively. Second antenna (fig. 89) with 4 segments having same formula for armature as in previous species. Three elements on third segment consisting of 2 naked setae 22μ and 23μ and a spiniform seta 11μ long and very finely spinulose. Last segment 74μ along outer margin, 40μ along inner margin, and 22μ wide. Two terminal claws not as long as in 4 previous species and unequal, one being 46μ and slender, other 43μ and much stouter.

Labrum as in *L. exilipes*. Mandible as in *L. fissisetiger*. Paragnath and first maxilla as in *L. exilipes*. Second maxilla (fig. 90) resembling in general form that of *L. fissisetiger*, but 4–5 central teeth on lash much stouter than others. Maxilliped much like that of *L. gentilis*.

Area between maxillipeds and first pair of legs not protuberant, with a sclerotized line between bases of maxillipeds.

Legs 1–4 segmented as in 4 previous species, with same spine and setal formula. Legs 1–3 closely resembling those of *L. exilipes*. Leg 4 (fig. 91) with endopod shorter than exopod, its first segment 41μ x 28μ (including terminal spinous processes) with inner distal finely barbed spine 30μ, second segment 90μ x 24μ (greatest dimensions including processes), outer terminal spine 29μ with finely barbed margins, inner 63μ with coarsely barbed fringe on outer margin and very slightly barbed fringe on inner margin. Inner margin of this segment with very short spinules.

Leg 5 (fig. 92) with elongated free segment having a prominent inner basal expansion directed distally. (Shape of this expansion varying somewhat in different individuals, as in figures 93 and 94.) Length of segment 134μ, width at expansion 40μ, width just distal to expansion 26μ. Outer surface with narrow scalelike spines. Two terminal setae 70μ and 88μ (the latter with a narrow membrane as in *L. fissisetiger*). Seta on body near insertion of segment about 40μ long and slightly plumose; a few small spinules near this seta.

Leg 6 probably represented by the 2 setae near areas of attachment of each egg sac (see fig. 86).

Color in life in transmitted light as in *L. fissisetiger*.

MALE.—Body (fig. 95) resembling that of *L. fissisetiger*. Length 0.73 mm (0.69–0.77 mm) and greatest width 0.26 mm (0.22–0.28 mm), based on 10 specimens. Ratio of length to width of prosome 1.73:1.

Segment of leg 5 measuring 34μ x 81μ. Genital segment (fig. 96) about as long as wide, 169μ x 164μ. No ventral intersegmental sclerite between these segments. Four postgenital segments 16μ x 46μ, 16μ x 45μ, 13μ x 44μ, and 18μ x 47μ respectively.

Caudal ramus similar to that of female but smaller, 17μ x 22μ dorsally, 19μ x 22μ ventrally.

Ratio of length of prosome to that of urosome 1.7:1.

Rostral area as in female. First antenna similar to that of female, but with 3 aesthetes added as in 4 previous species, so that formula is same as for those males. Aesthetes long as in *L. fissisetiger*, proximalmost almost 200μ in length. Second antenna like that of female, but with a few small spinules along inner margins of first, second, and fourth segments.

Labrum, mandible, paragnath, first maxilla, and second maxilla as in female. Maxilliped as in *L. gentilis*, with claw 146μ in length (measured along its axis).

Area between maxillipeds and first pair of legs as in female.

Legs 1–4 segmented as in 4 previous species, with spine and setal formula as in those males. Endopod of leg 1 as in *L. fissisetiger*. Legs 2–4 as in female.

Leg 5 as in *L. exilipes*, with free segment 51μ x 8μ, its seta 53μ and its spine 19μ in length.

Leg 6 similar to that of *L. fissisetiger*, with 2 naked setae 26μ and 53μ long.

Spermatophore not observed.

Color in life as in female.

ETYMOLOGY.—The specific name *cuneipes*, from Latin *cuneus*=a wedge and *pes*=a foot, alludes to the wedgelike form of the inner basal expansion of leg 5 in the female of this species.

COMPARISON WITH RELATED SPECIES.—*Lichomolgus cuneipes* may be differentiated from all other previously known species in the genus by the combination of two characters: the spine (instead of a seta) on the first segment of the endopod of leg 4 and the second antenna bearing terminally two claws and five small hyaline elements.

Lichomolgus cuneipes may be separated from all four species described above by the shorter and more unequal two claws on the

second antenna, by the nature of the teeth on the lash of the second maxilla, and by the form of the fifth legs in the female.

Lichomolgus aculeatus, new species

FIGURES 97–113

TYPE MATERIAL.—69 ♀♀, 116 ♂♂, and 39 copepodids from a colony of *Nephthea aberrans* Verseveldt, in 10 m, Tany Kely, a small island south of Nosy Bé, Madagascar, collected Aug. 21, 1964. Holotype ♀, allotype, and 154 paratypes (54 ♀♀ and 100 ♂♂) deposited in the United States National Museum, 20 paratypes (10 ♀♀ and 10 ♂♂) in the Zoölogisch Museum, Amsterdam, and the remaining paratypes in the collection of A. G. Humes.

OTHER SPECIMENS.—From *Nephthea sphaerophora* Kükenthal: 33 ♀♀, 17 ♂♂, and 11 copepodids from 1 colony, in 3 m, Pte. Lokobe, Nosy Bé, Oct. 16, 1960. From *Nephthea crassa* Kükenthal: 27 ♀♀, 46 ♂♂, and 33 copepodids from 1 colony, in 2 m, Pte. Mahatsinjo, Nosy Bé, Aug. 8, 1960; 51 ♀♀ and 97 ♂♂ from 1 colony, in 2 m, Tany Kely, Aug. 26, 1960. From *Nephthea tixierae* Verseveldt: 70 ♀♀, 92 ♂♂, and 100 copepodids from 1 colony, in 8 m, Nosy Ovy, Isles Radama, 13°59′S, 47°46.5′E, Sept. 30, 1964. From *Litophyton arboreum* Forskål: 189 ♀♀ and 47 ♂♂ from 1 colony, in 3 m, Andraikarekabe, western shore of Nosy Komba, near Nosy Bé, Oct. 9, 1964.

FEMALE.—Body (fig. 97) with moderately broad prosome. Length 1.26 mm (1.21–1.32 mm) and greatest width 0.57 mm (0.55–0.59 mm), based on 10 specimens. Segment of leg 1 separated from head by a distinct furrow. Epimeral areas of segments of legs 2 and 3 angular. Ratio of length to width of prosome 1.49:1.

Segment of leg 5 measuring 83μ x 190μ. Between this segment and genital segment no ventral intersegmental sclerite. Genital segment (fig. 98) longer than wide, 221μ x 195μ, its lateral areas not expanded. Areas of attachment of egg sacs situated dorsally near middle of segment. Each area with 2 minute naked setae. Three postgenital segments 75μ x 127μ, 44μ x 107μ, and 39μ x 110μ from anterior to posterior.

Caudal ramus (fig. 99) about 2.2 times longer than wide, 100μ x 48μ when measured dorsally, 110μ x 48μ when measured ventrally. Outer lateral seta 122μ long and naked; all other setae with prominent lateral spinules. Pedicellate dorsal seta 55μ, outermost distal seta 148μ, innermost distal seta 161μ, and the 2 long median terminal setae 213μ (outer) and 230μ (inner), both inserted between dorsal and ventral flanges bearing marginal spinules. Dorsal surface of ramus with fine ornamentation as in figure.

Ratio of length of prosome to that of urosome 1.7:1.

Egg sac (fig. 97) approximately 380μ x 200μ, reaching to insertion of caudal ramus, containing 8–11 eggs, each about 100μ in diameter.

Rostral area broadly rounded posteroventrally.

First antenna (433μ long) similar to that of *L. spinulifer* Humes and Frost, 1964, except that all setae are naked; segments 29μ (68μ along anterior edge), 125μ, 31μ, 64μ, 68μ, 46μ, and 31μ respectively. Second antenna (fig. 100) with 4 segments having same formula for armature as in previous species. Three elements on third segment consisting of 2 naked setae 49μ and 40μ and a spiniform seta 35μ barbed along one edge. Last segment 109μ along outer margin, 73μ along inner margin, and 30μ wide. Two terminal claws elongated, slender, and nearly equal, 140μ and 133μ.

Labrum (fig. 101) with 2 posteroventral lobes. Mandible (fig. 102) similar to that of *L. spinulifer*, but with a pointed prominence on its convex margin distal to proximal spinules. Paragnath and first maxilla as in *L. spinulifer*. Second maxilla (fig. 103) similar to *L. spinulifer*, but with first segment broadened so that convex margin of appendage is angular; long spinules on proximal edge of distalmost seta on second segment; small setule on proximal outer area of second segment (as in *L. spinulifer*). Maxilliped (fig. 104) resembling that of *L. spinulifer*, but differing in fine ornamentation; small seta on third segment (as in *L. spinulifer*).

Area between maxillipeds and first pair of legs as in *L. spinulifer*, with a sclerotized line between bases of maxillipeds as in that species.

Legs 1–4 segmented as in 5 previous species, with same spine and setal formula, and closely resembling those of *L. spinulifer*. Endopod of leg 4 (fig. 105) only slightly shorter than exopod, its first segment 55μ x 42μ (including terminal spinous processes) with an inner distal plumose seta 104μ long, second segment 125μ x 35μ (greatest dimensions including processes), outer terminal spine 25μ and finely barbed, inner 78μ with a finely serrated fringe. Outer margin of second segment with row of spinules (lacking distinct articulations) and inner margin smooth, as in *L. spinulifer*.

Leg 5 (fig. 106) similar to that of *L. spinulifer*, elongated free segment having a small proximal inner expansion. Length of segment 151μ, width at expansion 49μ, width near tip 16μ. Outer surface with scalelike spines. Two terminal naked setae 39μ and 88μ. Seta on body near insertion of segment 45μ and naked.

Leg 6 probably represented by the 2 setae near areas of attachment of egg sac.

Color in life in transmitted light opaque, eye red, ovary gray, egg sacs reddish gray.

MALE.—Body (fig. 107) resembling in general form that of female. Length 1.01 mm (0.96–1.07 mm) and greatest width 0.36 mm (0.35–

0.36 mm), based on 10 specimens. Ratio of length to width of prosome 1.56:1.

Segment of leg 5 measuring 44μ x 107μ. Genital segment (fig. 108) somewhat longer than wide, 239μ x 213μ. No ventral intersegmental sclerite between these segments. Four postgenital segments 26μ x 65μ, 23μ x 65μ, 18μ x 63μ, and 23μ x 70μ respectively.

Caudal ramus similar to that of female, 83μ x 39μ dorsally, 85μ x 39μ ventrally.

Ratio of length of prosome to that of urosome 1.45:1.

Rostral area as in female. First antenna similar to that of female, but with 3 aesthetes added as in 5 previous species, so that formula is same as for those males; aesthetes resembling those of *L. spinulifer*. Second antenna (fig. 109) resembling that of female, but with prominent spinules on inner margins of first 2 segments and small spinules added on segments 3 and 4 as in figure.

Labrum, mandible, paragnath, first maxilla, and second maxilla as in female. Maxilliped (fig. 110) resembling that of *L. spinulifer*, with claw 224μ along its axis.

Area between maxillipeds and first pair of legs as in female.

Legs 1–4 segmented as in 5 previous species, with spine and setal formula as in those males. Endopod of leg 1 (fig. 111) with long terminal spine recurved and concave inwardly, bearing 2 rows of strong spinules: outer spine short and differentially barbed on its 2 margins. Legs 2–4 as in female.

Leg 5 (fig. 112) with free segment 55μ x 10μ (extremes in 4 males 53μ–59μ x 9μ–11μ), its seta 44μ and naked, its spine 20μ with an outer fringe; seta on body near insertion of free segment 35μ and naked.

Leg 6 similar to that of *L. spinulifer*, the 2 small naked setae about 8μ long.

Spermatophore (fig. 113), attached to female, elongated, 195μ x 83μ, not including neck.

Color in life as in female.

ETYMOLOGY.—The specific name *aculeatus*, from Latin=provided with prickles, refers to the nature of the terminal spine on the endopod of leg 1 in the male of this species.

COMPARISON WITH RELATED SPECIES.—*Lichomolgus aculeatus* differs from all five species described above in having a seta (instead of a spine) on the first segment of the endopod of leg 4. The new species appears to be closely related to *L. spinulifer* Humes and Frost, 1964, from *Lemnalia* sp. at Nosy Bé, yet differs from it in several significant features: the relatively shorter caudal ramus (2.2:1, instead of 3.3:1 as in *L. spinulifer*), the long terminal claws on the second antenna, the small pointed process on the convex side of the mandible,

and the concave spinulose spine on the last segment of the endopod in the male.

Lichomolgus spinulifer Humes and Frost, 1964

This species has been previously recorded from *Lemnalia* sp. at Nosy Bé, Madagascar (Humes and Frost, 1964).

New host records.—From *Lemnalia flava* May: 211 ♀♀, 133 ♂♂, and 26 copepodids from 1 colony, in 1 m, Pte. Ambarionaomby, Nosy Komba, near Nosy Bé, Dec. 14, 1963. From *Lemnalia elegans* (May): 815 ♀♀, 1018 ♂♂, and 230 copepodids from several colonies, in 15 cm, Boloboxo, Nosy Faly, east of Nosy Bé, May 13, 1964. From *Lemnalia amabilis* Tixier-Durivault: 22 ♀♀, 26 ♂♂, and 15 copepodids from 1 colony, in 3 m, Pte. Ambarionaomby, Nosy Komba, Oct. 3, 1960. From *Lemnalia africana* (May): 59 ♀♀, 55 ♂♂, and 3 copepodids from 1 colony, in 2 m, Pte. Ambarionaomby, Nosy Komba, Sept. 27, 1964. From *Paralemnalia thyrsoides* (Ehrenberg): 60 ♀♀, 62 ♂♂, and 12 copepodids from 1 colony, in 3 m, Antsamantsara, northwest of Madirokely, Nosy Bé, Sept. 20, 1964.

These specimens conform completely with paratypes of *L. spinulifer*. The figures of Humes and Frost (1964) should be modified in certain details as follows: in their figures 142 and 160 of the second antenna, another minute element is present near the bases of the two terminal claws, making five such elements in all; in their figure 147 of the female second maxilla, there is a small seta on the proximal outer area of the second segment, and the distalmost seta on this segment has a few minute inner spinules near its tip; in their figure 148 of the female maxilliped, a small seta is present near the two terminal elements; and in their figures 151–154 (female) and 162 (male) of legs 1–4, the outer distal corner of the coxa bears a few small spinules.

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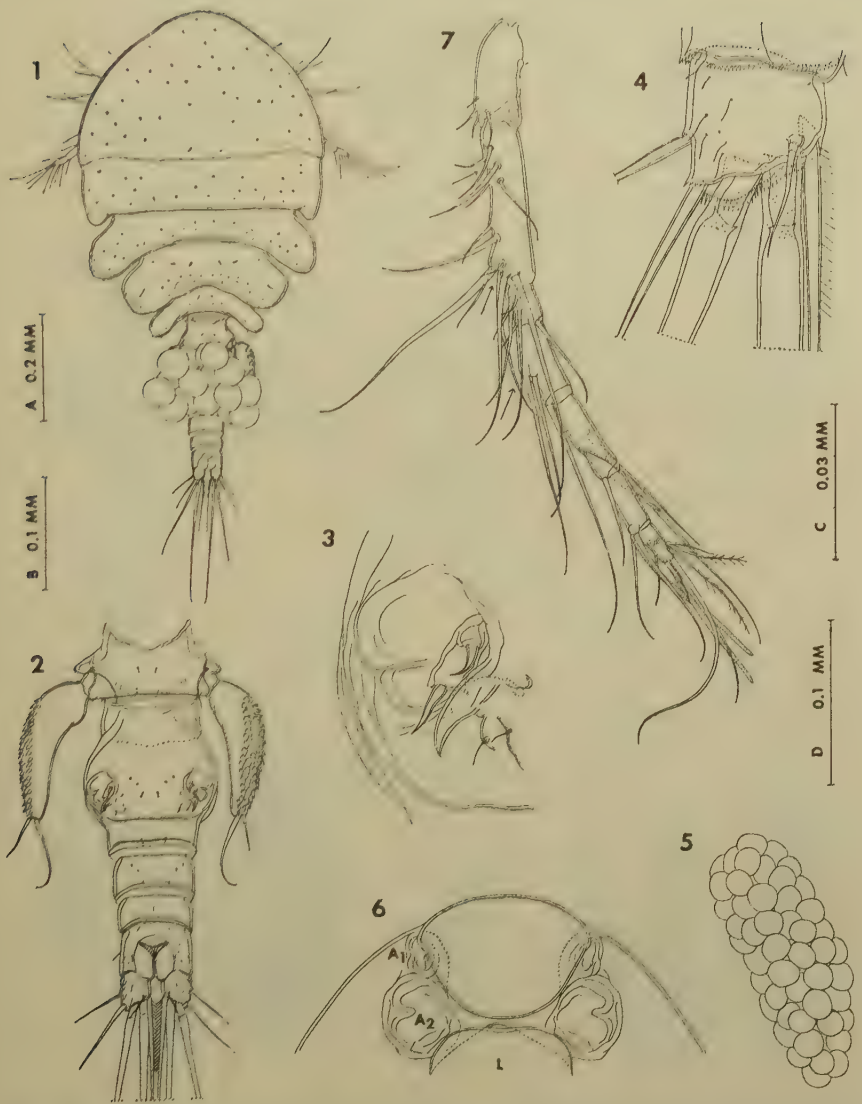
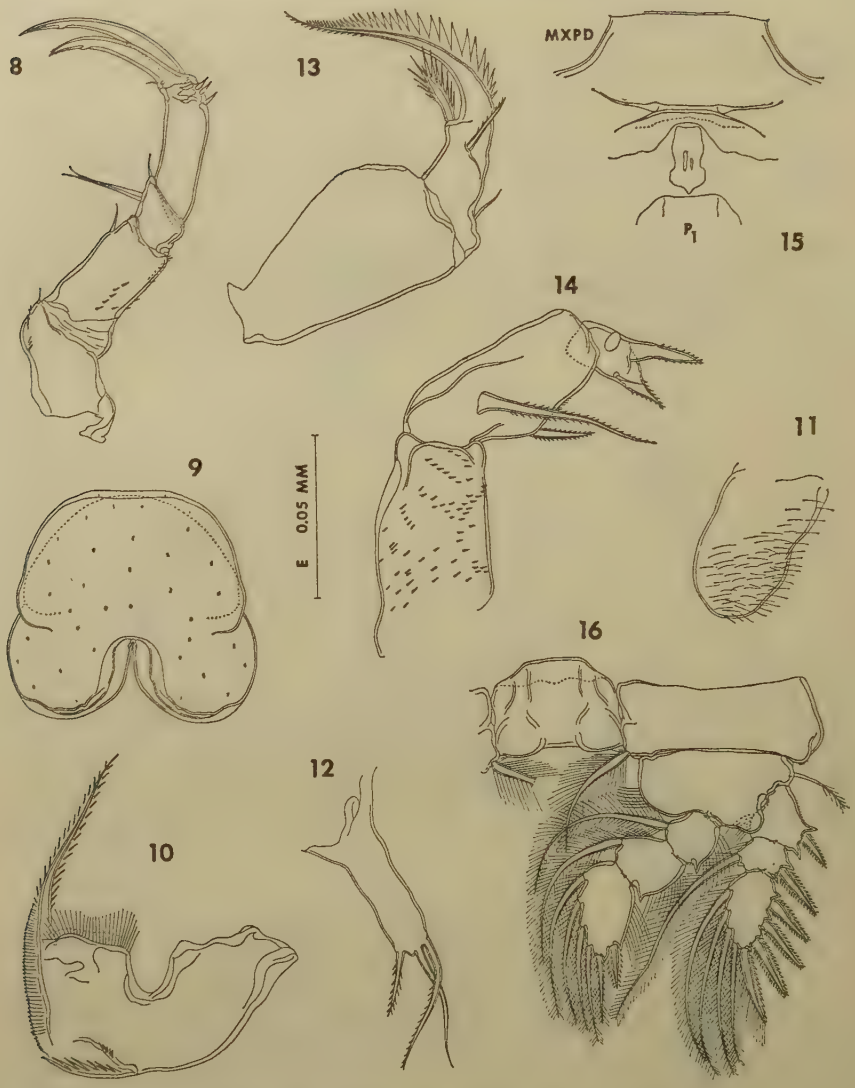
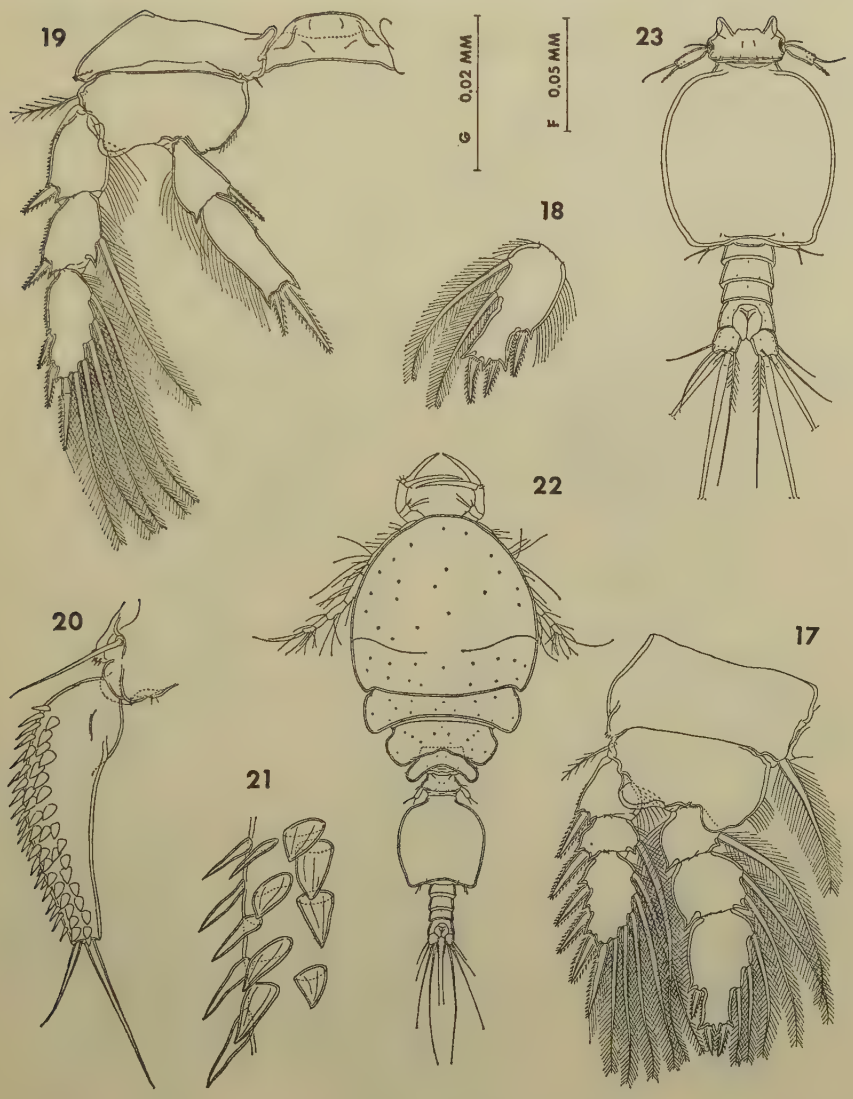


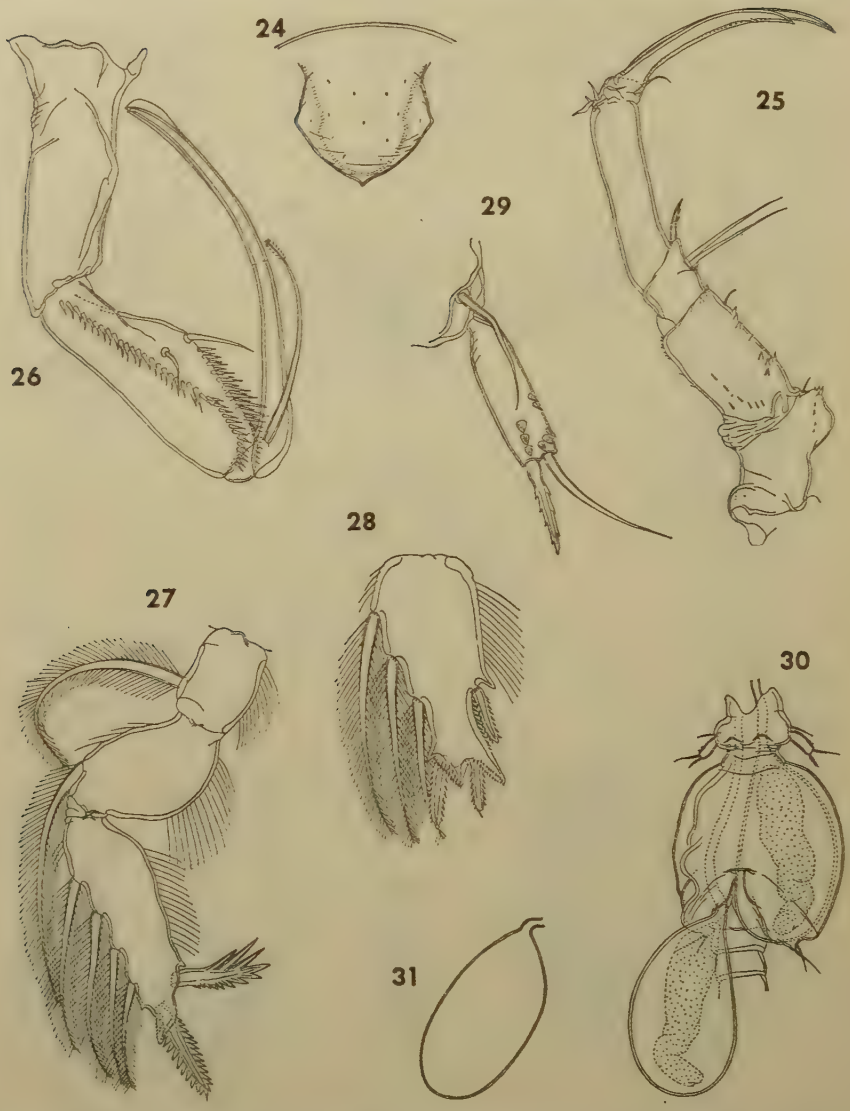
FIGURES 1–7.—*Lichomolgus varirostratus*, new species, female: 1, body, dorsal (A); 2, urosome, dorsal (B); 3, area of attachment of egg sac, dorsal (C); 4, caudal ramus, dorsal (C); 5, egg sac, dorsal (A); 6, rostral area, anteroventral (B); 7, first antenna, dorsal (D).



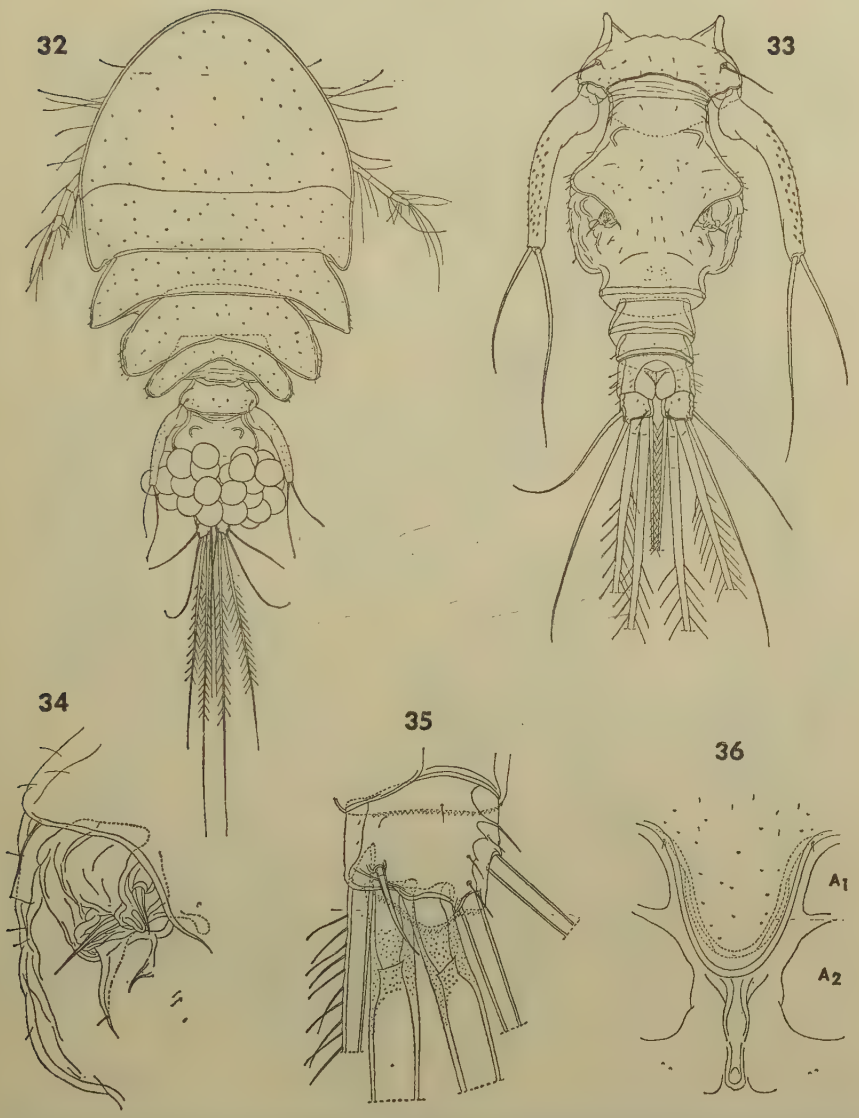
FIGURES 8–16.—*Lichomolgus varirostratus*, new species, female: 8, second antenna, anterior (inner) (D); 9, labrum, ventral (D); 10, mandible, posterior (E); 11, paragnath, ventro-inner (C); 12, first maxilla, anterior (E); 13, second maxilla, posterior (E); 14, maxilliped, postero-inner (E); 15, area between maxillipeds and first pair of legs, ventral (D); 16, leg 1 and intercoxal plate, anterior (D).



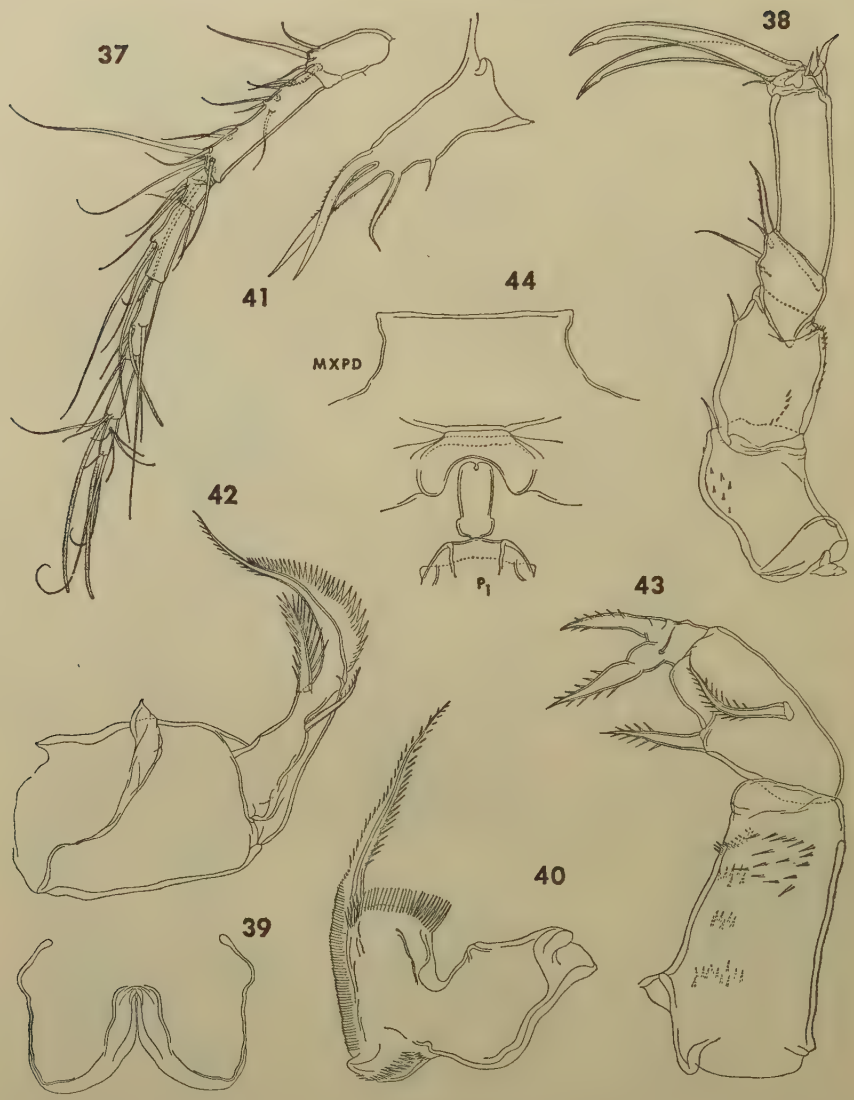
FIGURES 17–23.—*Lichomolgus varirostratus*, new species, female: 17, leg 2, anterior (D); 18, last segment of endopod of leg 3, anterior (D); 19, leg 4 and intercoxal plate, anterior (D); 20, leg 5, dorsal (F); 21, scalelike spines on leg 5, dorso-outer (G). Male: 22, body, dorsal (A); 23, urosome, dorsal (B).



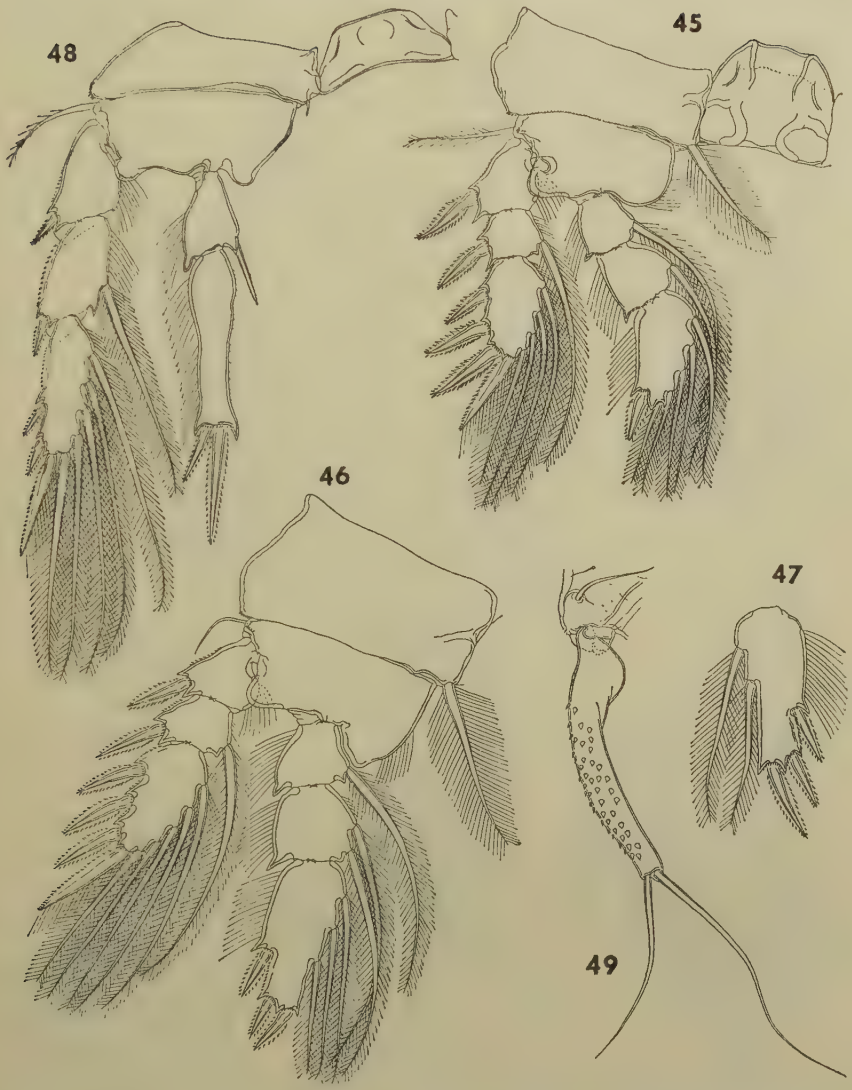
FIGURES 24–31.—*Lichomolgus varirostratus*, new species, male: 24, rostral area, ventral (D); 25, second antenna, anterior (inner) (F); 26, maxilliped, postero-inner (F); 27, endopod of leg 1, anterior (E); 28, last segment of endopod of leg 2, anterior (E); 29, leg 5, dorsal (C); 30, anterior part of urosome, showing extrusion of spermatophore in lactic acid, ventral (B); 31, spermatophore, attached to female, lateral (B).



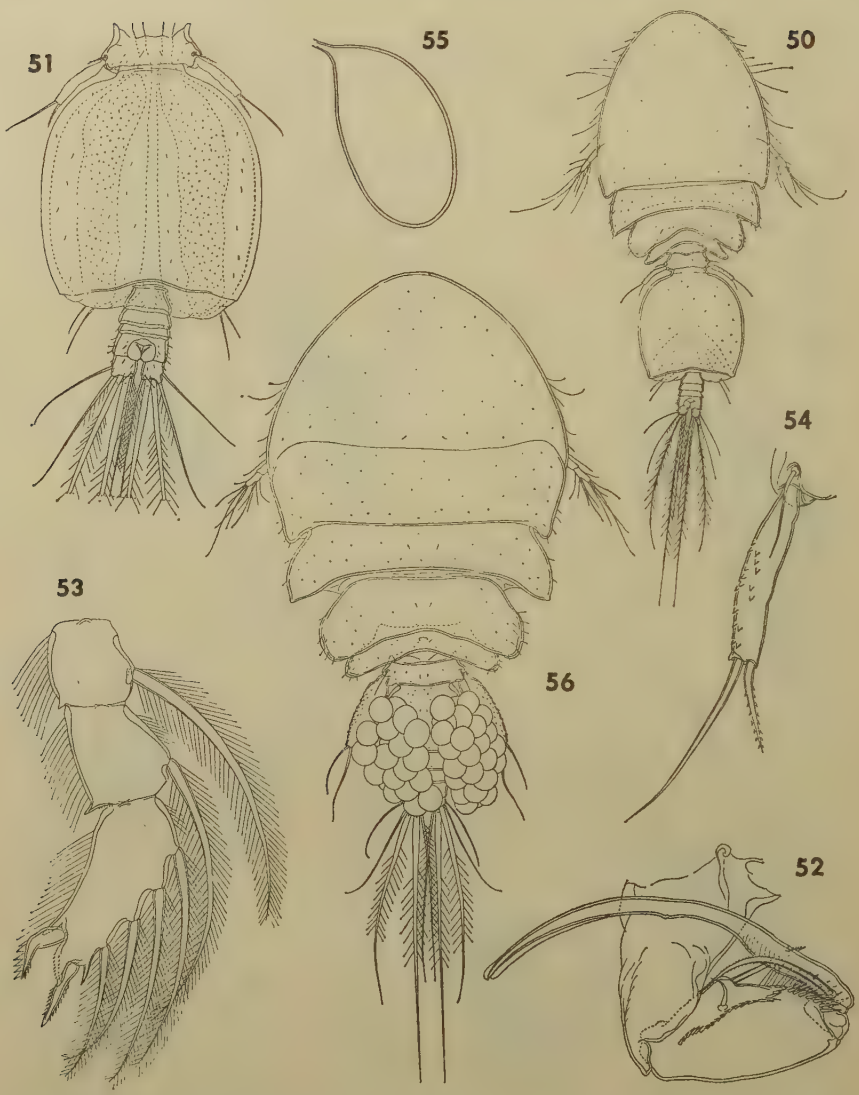
FIGURES 32–36.—*Lichomolgus exilipes*, new species, female: 32, body, dorsal (A); 33, urosome, dorsal (B); 34, area of attachment of egg sac, dorsal (E); 35, caudal ramus, dorsal (C); 36, rostral area, ventral (D).



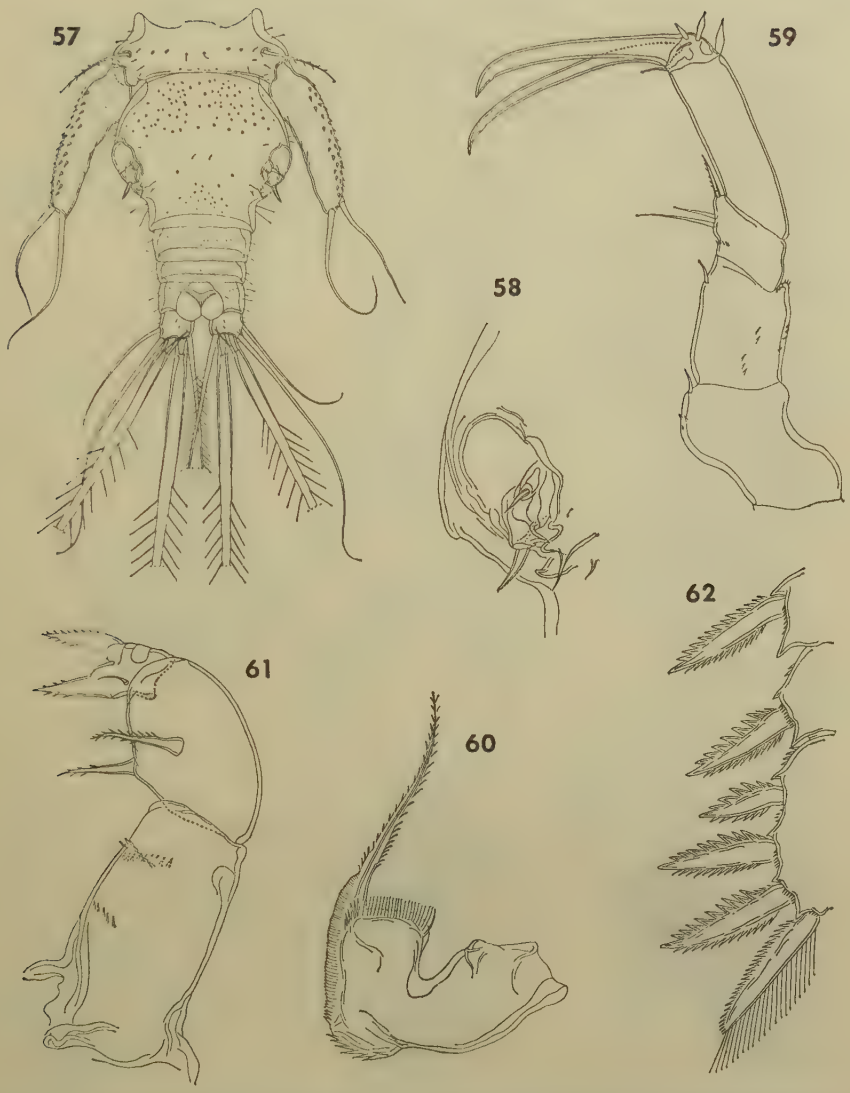
FIGURES 37–44.—*Lichomolgus exilipes*, new species, female: 37, first antenna, ventral (B); 38, second antenna, anterior (inner) (D); 39, labrum, ventral (F); 40, mandible, posterior (E); 41, first maxilla, posterior (E); 42, second maxilla, postero-inner (E); 43, maxilliped, postero-inner (E); 44, area between maxillipeds and first pair of legs, ventral (D).



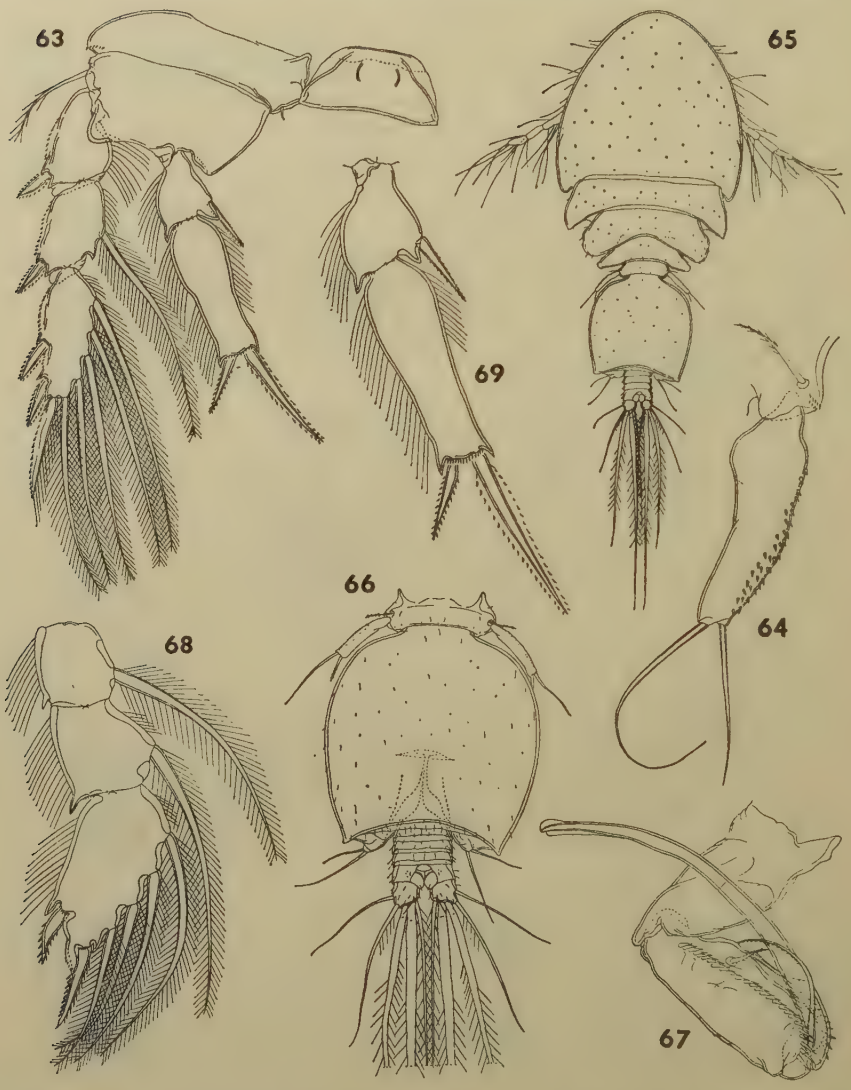
FIGURES 45–49.—*Lichomolgus exilipes*, new species, female: 45, leg 1 and intercoxal plate, anterior (D); 46, leg 2, anterior (D); 47, last segment of endopod of leg 3, anterior (D); 48, leg 4 and intercoxal plate, anterior (D); 49, leg 5, dorsal (D).



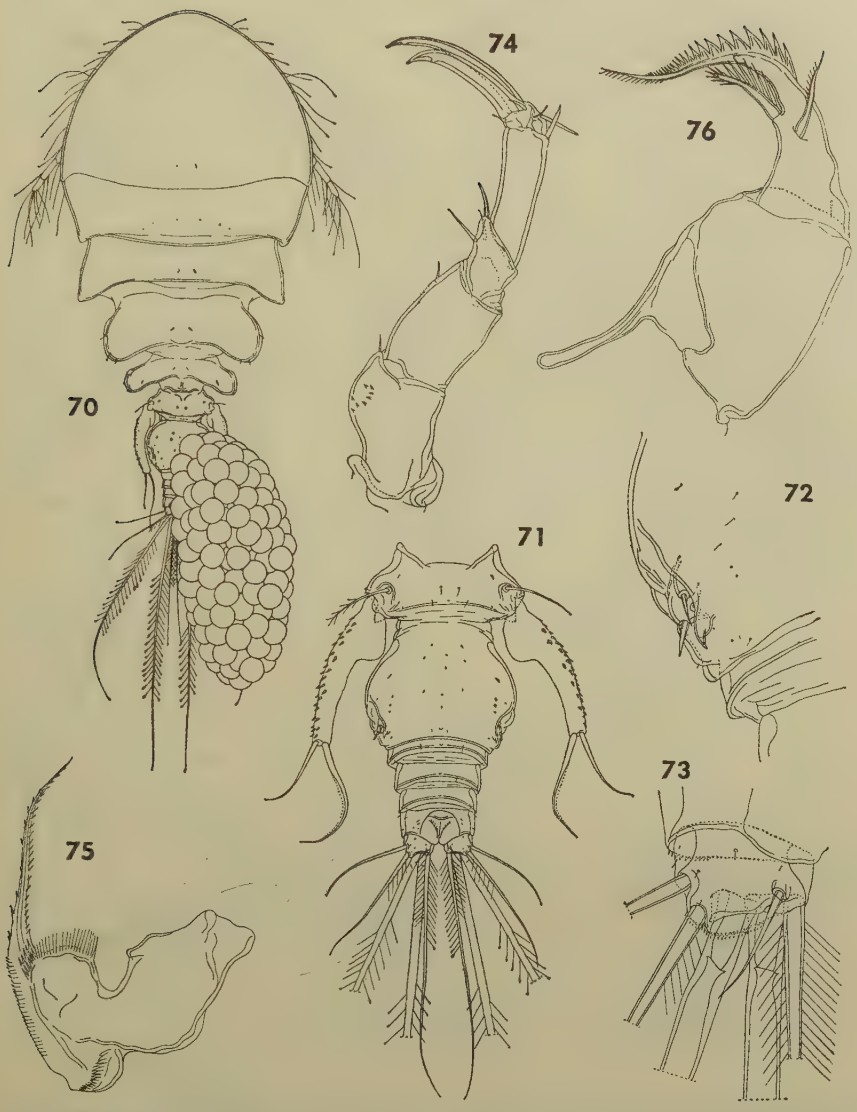
FIGURES 50–56.—*Lichomolgus exilipes*, new species, male: 50, body, dorsal (A); 51, urosome, dorsal (B); 52, maxilliped, postero-inner (F); 53, endopod of leg 1, anterior (E); 54, leg 5, dorsal (E); 55, spermatophore, attached to female, dorsal (B). *Lichomolgus gentilis*, new species, female: 56, body, dorsal (A).



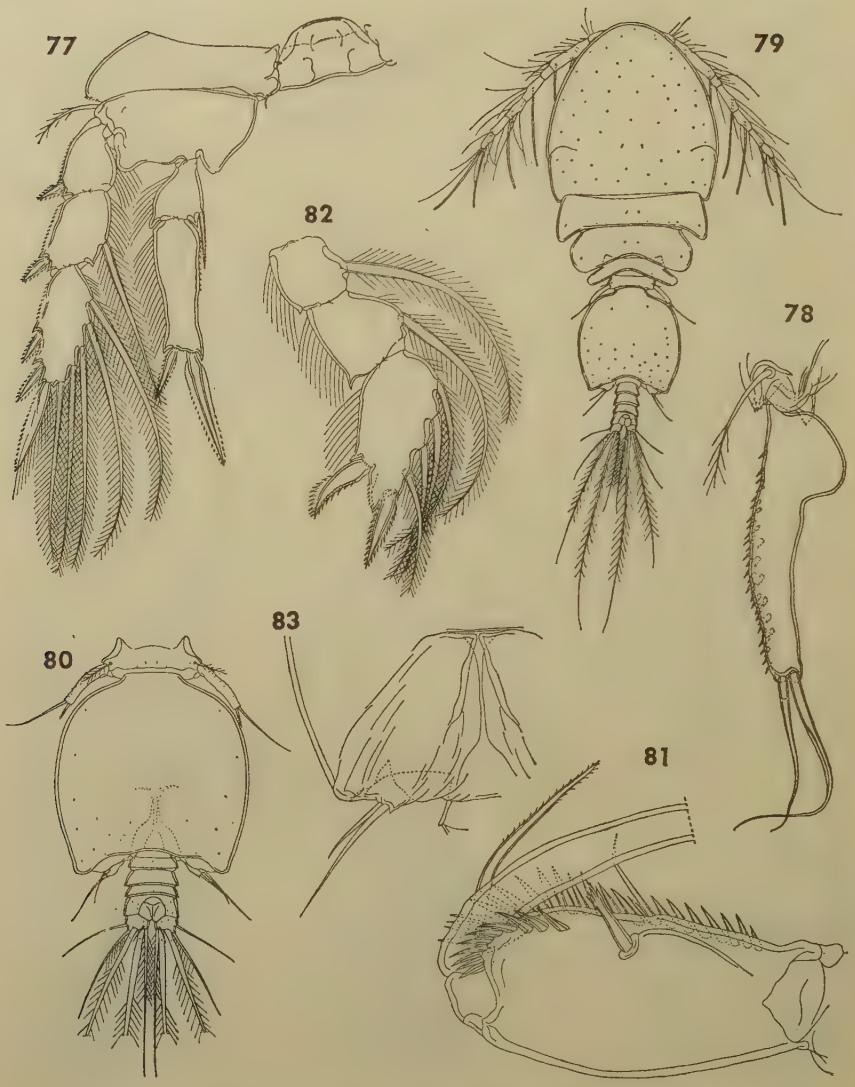
FIGURES 57–62.—*Lichomolgus gentilis*, new species, female: 57, urosome, dorsal (B); 58, area of attachment of egg sac, dorsal (E); 59, second antenna, anterior (inner) (D); 60, mandible, posterior (E); 61, maxilliped, postero-inner (E); 62, spines on exopod of leg 1, anterior (E).



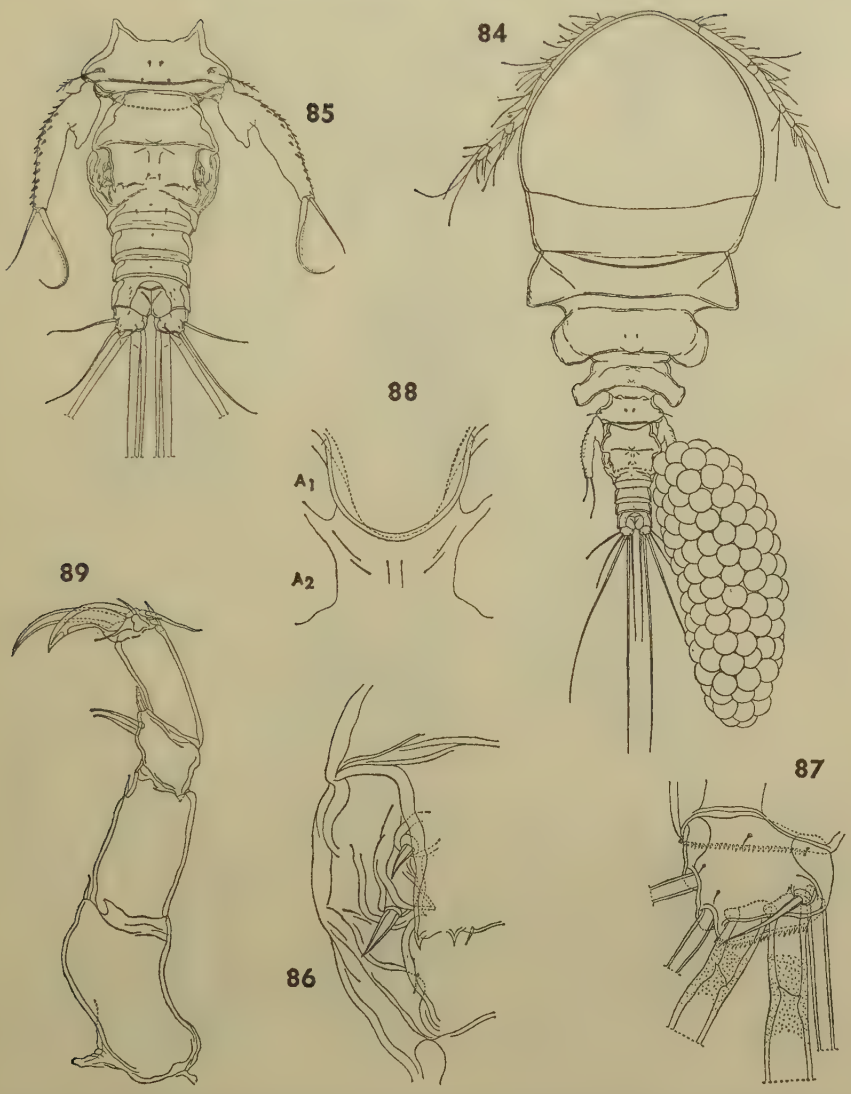
FIGURES 63–69.—*Lichomolgus gentilis*, new species, female: 63, leg 4 and intercoxal plate, anterior (D); 64, leg 5, dorsal (D). Male: 65, body, dorsal (A); 66, urosome, dorsal (B); 67, maxilliped, postero-inner (F); 68, endopod of leg 1, anterior (E); 69, endopod of leg 4, anterior (E).



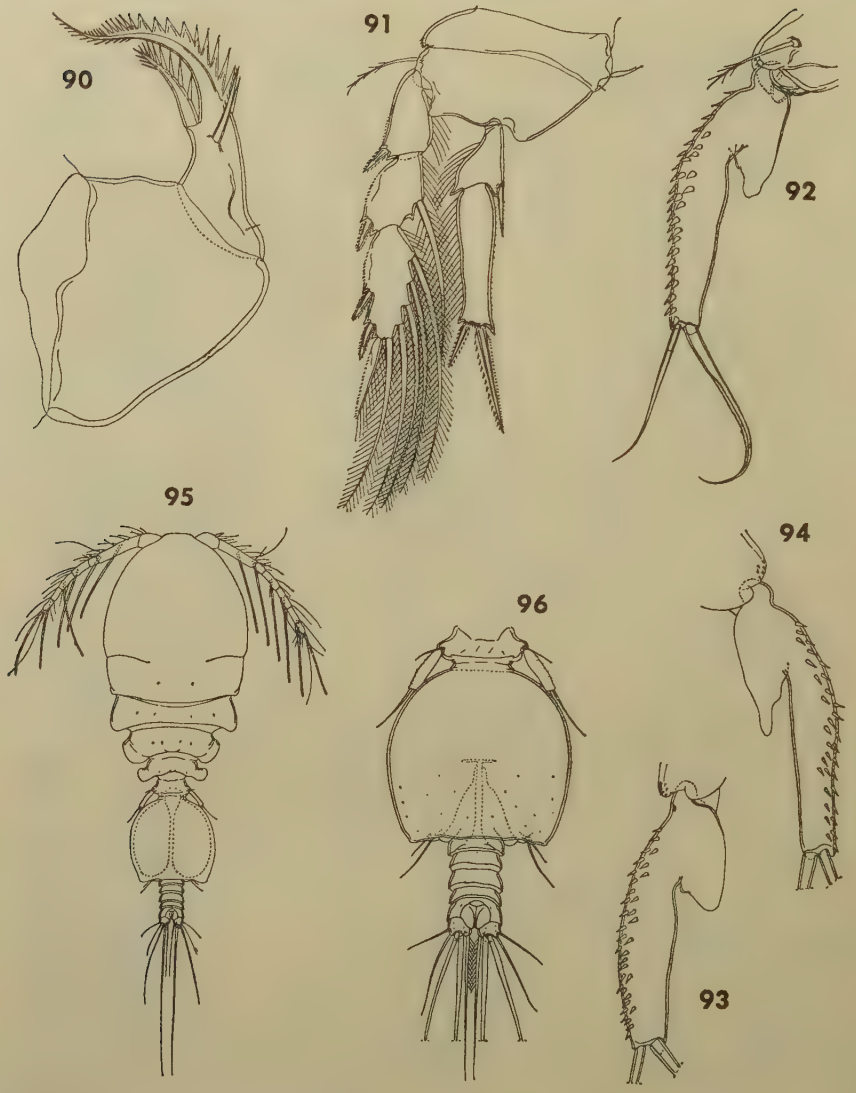
FIGURES 70–76.—*Lichomolgus fissisetiger*, new species, female: 70, body, dorsal (A); 71, urosome, dorsal (B); 72, area of attachment of egg sac, dorsal (E); 73, caudal ramus, dorsal (C); 74, second antenna, anterior (inner) (D); 75, mandible, posterior (E); 76, second maxilla, posterior (E).



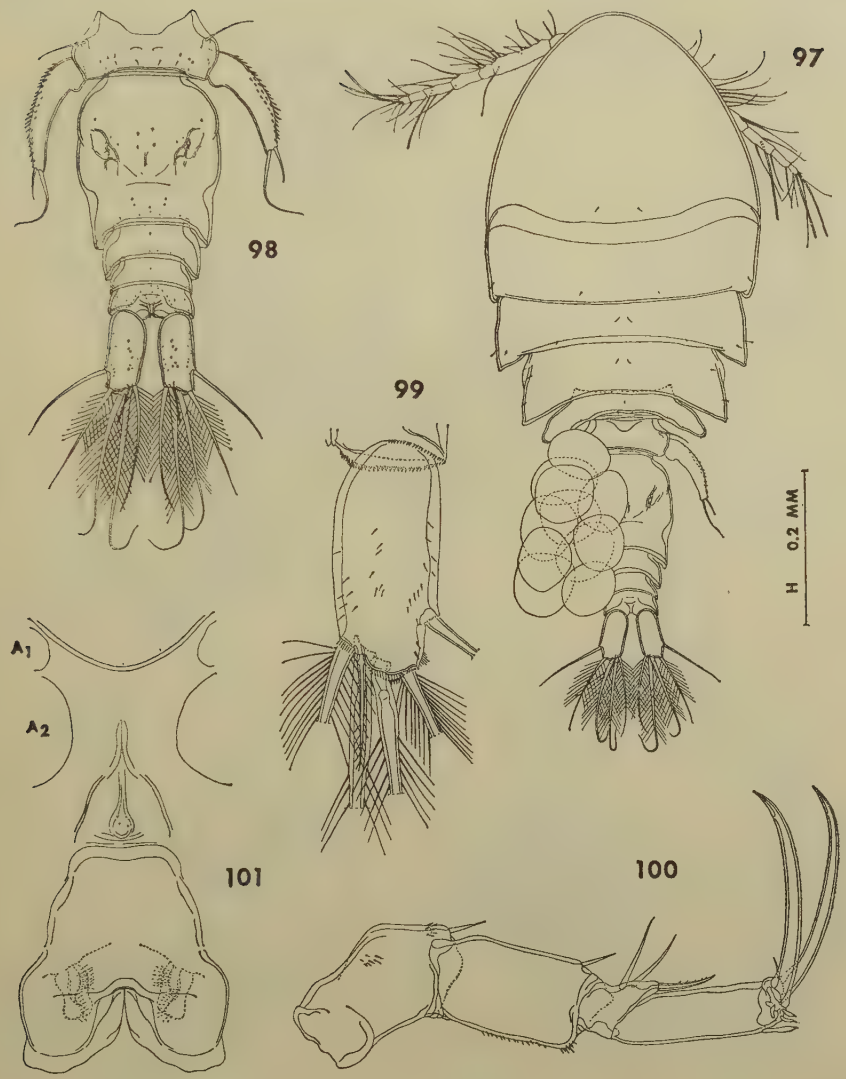
FIGURES 77–83.—*Lichomolgus fissisetiger*, new species, female: 77, leg 4 and intercoxal plate, anterior (D); 78, leg 5, dorsal (F). Male: 79, body, dorsal (A); 80, urosome, dorsal (B); 81, maxilliped, second and third segments and proximal part of claw, ventro-outer (C); 82, endopod of leg 1, anterior (E); 83, leg 6, ventral (F).



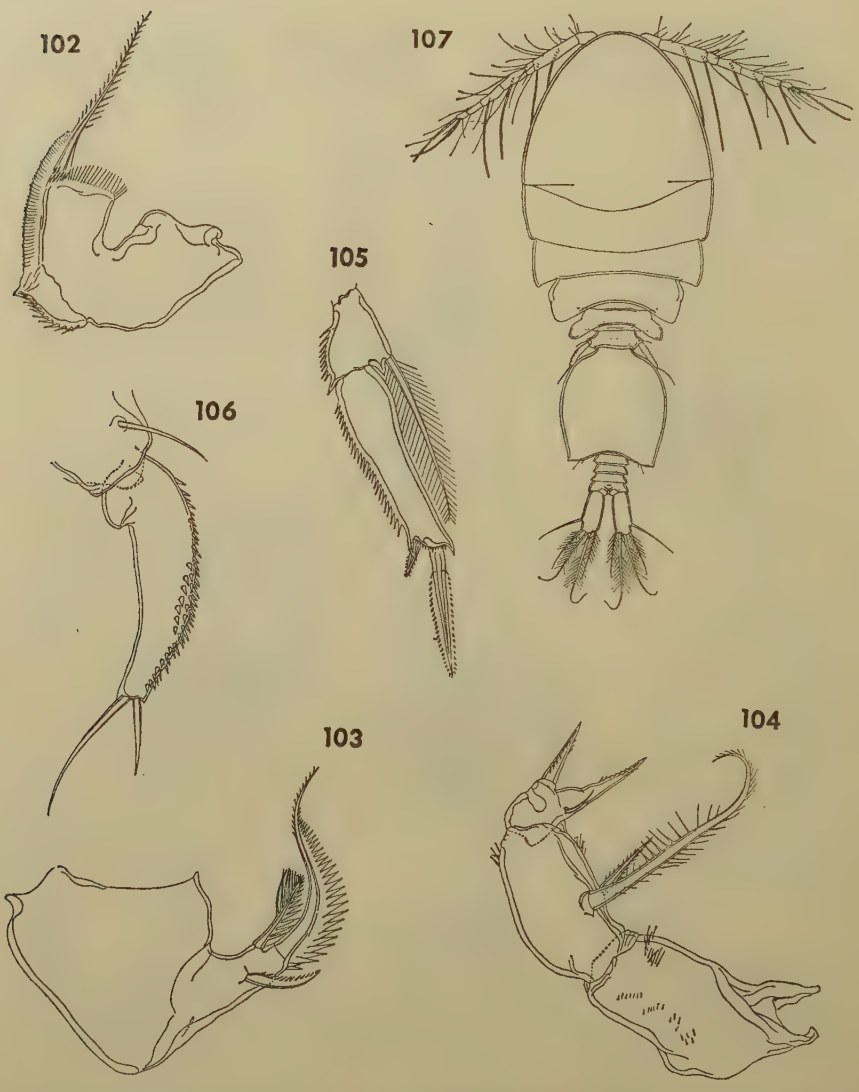
FIGURES 84–89.—*Lichomolgus cuneipes*, new species, female: 84, body, dorsal (A); 85, urosome, dorsal (B); 86, area of attachment of egg sac, dorsal (C); 87, caudal ramus, dorsal (C); 88, rostral area, ventral (D); 89, second antenna, anterior (inner) (F).



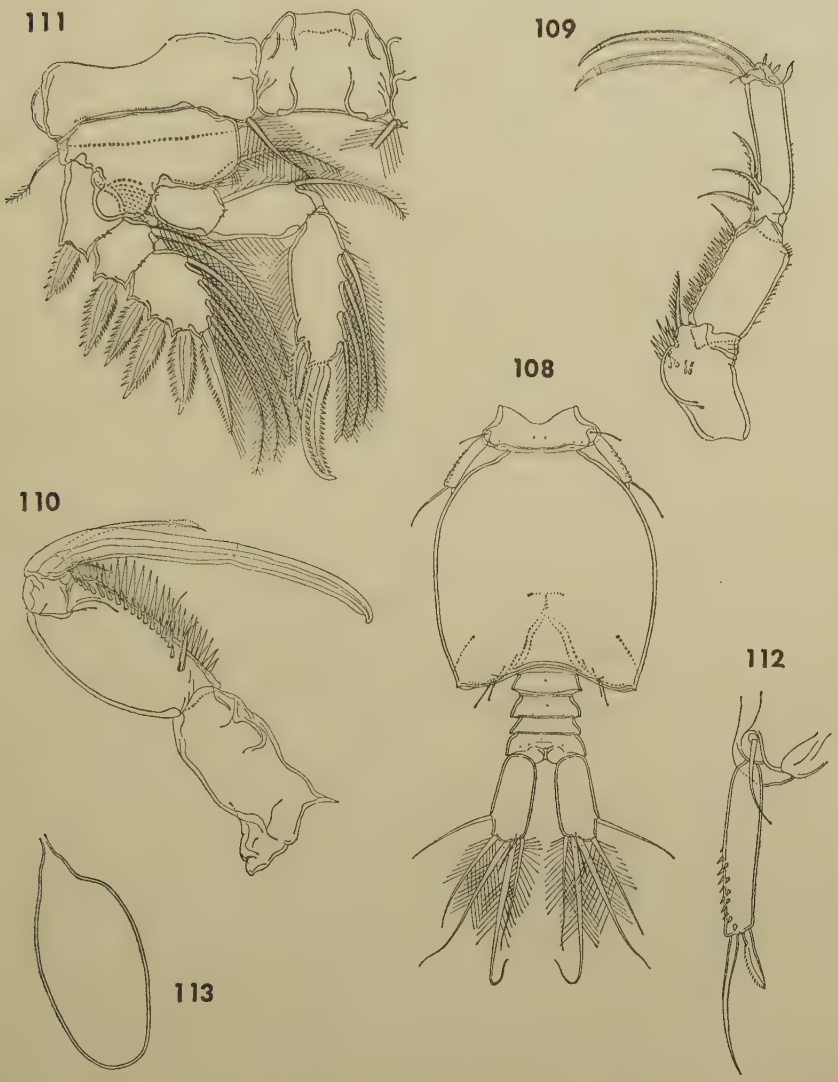
FIGURES 90–96.—*Lichomolgus cuneipes*, new species, female: 90, second maxilla, postero-inner (E); 91, leg 4, anterior (D); 92, leg 5, dorsal (F); 93, free segment of leg 5, dorsal (F); 94, free segment of leg 5, dorsal (F). Male: 95, body, dorsal (A); 96, urosome, dorsal (B).



FIGURES 97–101.—*Lichomolgus aculeatus*, new species, female: 97, body, dorsal (A); 98, urosome, dorsal (H); 99, caudal ramus, dorsal (F); 100, second antenna, anterior (inner) (D); 101, rostral area and labrum, ventral (D).



FIGURES 102–107.—*Lichomolgus aculeatus*, new species, female: 102, mandible, posterior (F); 103, second maxilla, posterior (F); 104, maxilliped, posterior (F); 105, endopod of leg 4, anterior (D); 106, leg 5, dorsal (D). Male: 107, body, dorsal (A).



FIGURES 108–113.—*Lichomolgus aculeatus*, new species, male: 108, urosome, dorsal (B); 109, second antenna, posterior (outer) (D); 110, maxilliped, ventro-outer (D); 111, leg 1 and intercoxal plate, anterior (F); 112, leg 5, dorsal (E); 113, spermatophore, attached to female, ventral (B).

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